

ENVIRONMENTAL ATLAS FOR BEAUFORT SEA OIL SPILL RESPONSE

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for:
Environment Canada
Environmental Protection Service

produced by:
DF Dickins Associates Ltd.
and
ESL Environmental Sciences Limited.

Dome Petroleum's "Oil and Gas Under Sea Ice Study" site in
McKinley Bay, June 1980. Beaufort Sea CO-OP Oil Spill
Response Barge in Background.
Photograph: D. Dickins

Environmental Atlas for Beaufort Sea Oil Spill Response

by

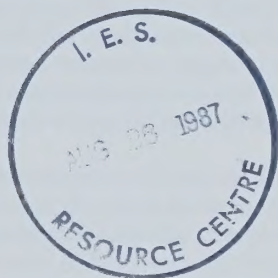
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**Environment Canada
Environmental Protection Service
Yellowknife, N.W.T. and Whitehorse, Yukon**

March 1987

**Produced by:
DF Dickins Associates Ltd.
and
ESL Environmental Sciences Limited
In association with:
SL Ross Environmental Research Limited
Erickson Associates
Dobrocky Seatech Ltd.
PN Research Projects
LGL Limited**



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published by
DF Dickins Associates Ltd.
3732 West Broadway
Vancouver, B.C.
Canada V6R 2C1

ISBN 0-921623-03-8

59246593

PREFACE

This atlas represents a significant achievement by a diverse group of specialists in many different disciplines including engineering, biology, sociology, geography, and computer technology. Individual responsibilities and contributions to the atlas are outlined below.

Study Team

DF Dickins Associates Ltd. was the prime contractor with overall responsibility for production of the atlas. David Dickins directed the project in association with the study team managers in the key scientific areas of biological resources, physical environment, human use and oil spill countermeasures, and developed a marine oil residence category for environmental sensitivity ranking.

Linda Martin of ESL Environmental Sciences Limited was responsible for all aspects of the atlas concerned with biological resources and environmental sensitivity. Stephen Johnson of LGL Limited and Pamela Norton of PN Research Projects compiled biological resource information and provided sensitivity rankings for birds and marine mammals, respectively. Patricia Vonk of ESL provided research support and compiled information relating to archaeological sites, park boundaries, and special status areas.

Diane Erickson of Erickson Associates developed the information base on human coastal and offshore use of the region and interpreted the sensitivity elements related to resource harvesting and locally identified cultural sites.

Ingrid Bjerkelund of DF Dickins Associates Ltd. prepared all information describing the physical environment (ice and climate) and logistics, developed the overall atlas layout and assisted with final production of the atlas.

Stephen Potter of SL Ross Environmental Research Limited developed the text sections concerned with shore access and countermeasures, and selected potentially acceptable oil disposal sites.

John Harper of Dobrocky Seatech Ltd. mapped shoreline types and backshore inundation limits, and developed and applied a shore zone oil residence category for environmental sensitivity ranking.

John McDonald of ESL Environmental Sciences Limited managed the computer production of all maps contained in the atlas. Peter Brouwer was in charge of digitization of map bases and overlay information and final plotting. Rod Olafson carried out specialized software development, including modifications to enable downloading of the Canadian Hydrographic Service digital chart data base for the Beaufort Sea.

Funding Agencies

The majority of funding for this project was provided through the Department of the Environment and the Department of Indian Affairs and Northern Development, through the Northern Oil and Gas Action Program (NOGAP) Fund. Other contributing departments and agencies were:

Beaufort Mackenzie Delta Development Impact Zone Society

Beaufort Sea Oil Spill Cooperative (Dome, Gulf, Esso)

Canada Oil and Gas Lands Administration, Ottawa

Canadian Coast Guard, Department of Transport, Western Region

COPE Land Use Planning Office

Department of Indian Affairs and Northern Development, Northern Affairs Program, Yukon

Department of Indian Affairs and Northern Development, Northern Land Use Planning Directorate, Yukon

Environmental Protection Service, Environment Canada, Pacific and Yukon Region

Environmental Protection Service, Environment Canada, Ottawa

Freshwater Institute, Department of Fisheries and Oceans, Western Region

Government of the Northwest Territories, Department of Renewable Resources

Government of the Yukon, Department of Renewable Resources

Institute of Ocean Sciences, Department of Fisheries and Oceans, Pacific Region

Chevron Canada Resources Limited

ACKNOWLEDGEMENTS

The study team would like to gratefully acknowledge the following agencies and individuals for their contributions to the atlas project:

Neil Parker of the Atmospheric Environment Service for providing all of the climatic data required;

The Canadian Hydrographic Service, Department of Fisheries and Oceans for making their digital chart data base for the Beaufort Sea available to this project, in particular Sev Crowther and Stephen McPhee;

Captain E.R. Cross of the Canadian Armed Forces Northern Region (Air) for providing an inventory of all existing airstrips along the Beaufort Sea coast, together with guidelines for safe aircraft operations on ice runways;

Brian Smiley of the Institute for Ocean Sciences for providing a critical review of the sensitivity ranking system at a crucial stage in its development;

Dave Sullivan of the Beaufort Mackenzie Delta Development Impact Zone Society for coordinating the selection of participants and the arrangements for a highly successful workshop held with Beaufort Sea residents in Inuvik to develop an information base on resource harvesting and cultural sites of local importance;

Tom Nesbitt of COPE Land Use Planning for providing valuable assistance with planning and execution of the Inuvik workshop;

The Beaufort Sea regional residents representing the communities of Tuktoyaktuk, Aklavik, Inuvik and Old Crow who participated in the success of the Inuvik workshop: Ada Carpenter, Helen Gruben, Jimmy Jacobsen, Frank Pokiak, Fred Wolki, Tom Arey, Andy Kayotuk, Renie Arey, Alex Aviugana, Emma Dick, David Roland and George Vittrekwa;

Jacques Cinq-Mars of the Archeological Survey of Canada for providing the computerized National Inventory of Prehistoric Sites for inclusion in the atlas;

George McCormick of Canada Oil and Gas Lands Administration for providing maps showing locations of oil and gas discoveries;

Tom Barry of Canadian Wildlife Service for providing valuable information regarding biological resources and their use of the area;

Jackie Cheng of Whole Note Contract Services Ltd. and Rick Hoos of Dome Petroleum Limited for providing access to resource harvesting information collected for the Beaufort Sea Environmental Impact Statement;

Morrie Zaitlin for providing desktop publishing services to produce the atlas copy;

Karen Goodrick for word processing the atlas text;

Ben Hubert of the NWT Land Use Planning Commission for supporting the project within the NWT;

Members of the project steering committee who contributed to the ongoing review process and provided advice to the scientific authority on all aspects of the project; and

Doug Kittle of the Environmental Protection Service, Yukon District, for enlisting the support of government agencies in the Yukon.

The study team greatly appreciates the efforts of the scientific authority, David Tilden of the Environmental Protection Service, Yellowknife, in lobbying on behalf of the project in the face of severe budget and time restrictions.

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1.0 INTRODUCTION

Objectives

The primary objective of the atlas is to provide a synthesis of environmental information relevant to the planning and implementation of year-round oil spill countermeasures in both coastal and offshore areas of the Beaufort Sea. **The atlas is intended to be used as a link between the environmental characteristics of the region and the practical considerations of providing an effective response to marine oil spills, but not as an oil spill manual.**

Hopefully this work will lead to better utilization of available resources and to reduced environmental impact in an actual Beaufort Sea spill incident.

This atlas was developed to meet the needs of industry, government, and local community groups for a document specifically related to offshore, year-round oil field development in the Beaufort Sea.

Motivation for the project stemmed from the realization in 1983 that none of the existing manuals and atlases related to oil spill response addressed the question of year round sensitivity of both coastal and offshore areas to oil spills in ice and open water.

The emphasis throughout the atlas is on the presentation of selected information in a concise, graphic form with important supporting text. The selection of information is intended to satisfy a wide variety of perceived user groups, including: government scientists, Coast Guard and industry response teams, policy directors, regulatory agencies, Beaufort Sea community organizations, and land use planners.

Worbets' "Shoreline Oil Spill Protection & Cleanup Strategies: Southern Beaufort Sea" (1) provided a model for the atlas in terms of physical layout, operational map scales, and general concepts of sensitivity ranking. In addition, "A Manual for the Preparation of Shoreline Protection and Cleanup Plans" (2) prepared by F. Beech of the Environmental Protection Service, Pacific and Yukon Region, was used as a guide for general format and map presentation. Apart from these similarities, the current atlas represents a completely new information base, which is organized, mapped, and presented entirely as a computer-generated product. The atlas can be updated at any time by entering new information to replace or augment the existing files.

The atlas is useful in three major areas: first to assist in the development of the most effective contingency plans for a specific area; second to provide a source document on which to base realistic oil spill training exercises; and third to act as a basic field reference to important environmental factors in an actual spill situation. Information contained in the atlas must be supplemented by local knowledge and real time information in the event of a spill.

Contents and Organization

The study area covers the southern Canadian Beaufort Sea from the United States/Canada border on the west to Baillie Islands on the east. The actual coastline exceeds 2,700 km in length while the direct east-west distance across the study area is only 520 km (1). The northerly extent of the study area is based on the median location of the polar pack edge ($\geq 5/10$ old ice). The southern boundary of the area is determined by the backshore limits of potential contamination from a marine oil spill. These limits are defined as the maximum area of inundation which could occur during positive storm surge events (onshore winds).

The atlas is organized by map scale, moving from the summary to the regional to the operational scale. The bulk of the atlas information is presented at the operational scale of 1:150,000 using maps derived from the Canadian Hydrographic Service (3) charts of the Beaufort Sea.

Information is grouped as follows according to the different map scales:

SUMMARY MAPS

Scale 1:2,500,000

- Oil and Gas Discoveries and General Bathymetry
- Overview - Areas of High Environmental Sensitivity: Shoreline and Offshore
- Offshore Environmental Sensitivity
- Areas of Special Status
- General Ice Conditions:
 - Winter Ice Zones
 - Cape Bathurst Polynya
 - Summer Ice Zones

- Ice Clearing Dates
- Open Water Season
- Ice and Water Movement

Offshore Access and Countermeasures Information for Winter and Summer Conditions

REGIONAL MAPS

Scale 1:1,000,000

Offshore Environmental Sensitivity During Winter and Spring

Offshore Environmental Sensitivity During Summer and Fall

Landfast Ice Conditions:

- Landfast Ice Development
- Winter Landfast Ice
- Landfast Ice Break-up
- Ice Growth and Ablation Curves
- Ice Bearing Capacity
- Ice Ridge Frequency

First Dates Ice Free - Examples of Early and Late Ice Clearing

OPERATIONAL MAPS

Scale 1:150,000

Shoreline Environmental Sensitivity:

- Biological Resources
- Resource Harvesting Areas
- Resource Harvesting Camps
- Archaeological Sites
- Heritage Sites (locally identified)
- National or Territorial Parks
- Sensitivity Rankings
- Occurrence of Species and Resource Use
- Environmental Description

Physical Environment and Logistics

- Shoreline Type
- Areas Inundated During Storm Surge Events
- Locations of Artificial Islands
- Anchorages
- Inlet Widths
- Spot Soundings (**Not to be used for navigation**)
- Airstrips

- Oil Disposal Sites
- Shore Access for Barge Offloading
- Description of Countermeasures
- Description of Access Limitations

Tactical maps are inserted into the operational map series at different scales for specific areas where more detailed charts are available (Workboat Passage, Tuktoyaktuk Harbour, McKinley Bay, and Nicholson Island).

Sensitivity Ranking

The environmental sensitivity ranking system used in the atlas was developed to describe the relative sensitivity of shoreline and offshore areas of the Beaufort Sea to the effects of oil spills. The sensitivity ranking system is based on a total of 20 environmental elements ranked within three categories: (1) human use sensitivity; (2) biological sensitivity; and (3) shore zone oil residence or marine oil residence. The marine oil residence category was developed specifically for this atlas to allow the overall sensitivity of offshore areas to be determined.

The entire study area is divided into sensitivity areas to enable the application of 20 sensitivity elements and to determine the overall environmental sensitivity. Environmental sensitivities for 69 shoreline areas are shown on the operational maps. Sensitivity rankings for 11 offshore areas in the summer and fall, and 15 offshore areas in the winter and spring are presented on summary and regional maps.

Shoreline environmental sensitivity area boundaries are indicated on each operational map. Each area extends approximately one kilometre offshore and backshore to include the maximum extent of positive storm surges. Shoreline environmental sensitivity values apply only for the period late May through October, when oil could be exposed in an unfrozen state along the shore.

Offshore environmental sensitivity was determined independently from shoreline sensitivity, and was analyzed for two periods: (1) summer and fall (July 17 to October 1) and (2) winter and spring (October 2 to July 16). The numbers and boundaries of offshore

sensitivity areas are dictated by typical seasonal locations of distinct ice and open water zones. In the event of an actual spill, the offshore sensitivity area boundaries may differ greatly from those shown in the atlas depending on the ice conditions present at the time.

The sensitivity rankings are intended as a tool to assist users of the atlas in making critical oil spill clean-up decisions either on site or in a planning/training situation. Each ranking value represents a distillation of a large amount of information in the physical, biological, and social sciences. In order to avoid misinterpretation it is essential to consider all of the background information that went into the ranking of a particular area before making a response decision. This background information is readily accessible on the maps, in the accompanying text description, and in Appendix A.

Black symbols are used to indicate: (1) the location of a large area where a significant proportion of the regional population of the species, or group of species, may occur at some time of the year and, (2) the location where resource harvesting activities take place. Fewer numbers of these same species and less intense resource harvesting may occur in many other areas included in the atlas; but, symbols have been placed only where significant numbers of individuals have been observed during several years or in areas that workshop participants identified as important for resource harvesting. The specific criteria used for determining significant numbers of each species are described in Appendix A. A different coloured symbol is used to indicate situations where a very restricted area (less than approximately 50 km²) is used by a significant proportion of the regional population. Users should be guided by what the symbol represents rather than be restricted by its exact location or by the lack of a particular biological or resource harvesting symbol. This volume is not intended as an exhaustive biological resource atlas.

References

Numbers in brackets throughout the atlas indicate the reference number. References are numbered by subject. See Section 5.0 for a complete listing of all references by subject category.

Appendices

Appendix A provides the background information and the detailed environmental sensitivity rankings necessary to properly interpret the summary values and relative sensitivity rankings (High, Moderate, Low) shown on the maps.

Appendices B, C, and D include graphs of climatic data, an index of place names (cross referenced according to map number and coordinates), and a nomenclature of useful ice terminology, respectively.

Documentation of software products used to generate this atlas and archival access information are contained in Appendix E.

PHYSICAL ENVIRONMENT AND LOGISTICS

USERS' GUIDE

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip -

Hydrographic Chart -

Video Tapes -

Coastal Type Descriptions

Information on coastal types mapped on the operational maps is derived from 1:50,000 coastal resource maps originally prepared by Dobrocky Seatech (4).

Tundra Cliffs:

Cliffs cut into unconsolidated, but frozen coastal plain sediments; usually rapidly retreating (1 to 2 m/yr); narrow, fringing gravel beaches are frequently associated with the cliffs.

Inundated Tundra:

Very low tundra that has been inundated such that the tundra surface is now below mean sea level; in effect a tundra mat extends below the water surface; coastal retreat rates are characteristically high (1 to 2 m/yr), although this coastal type frequently occurs within low wave exposure embayments.

Barrier Beaches and Spits:

Frequently interspersed with tundra cliffs along the coast; the barrier islands and spits are low in elevation, usually less than 2.5 m above mean water level; substrate is most commonly a mixture of sand and gravel; coastal stability is usually controlled by the rate of headland retreat of nearby tundra cliffs although some barrier spits are actually prograding.

Deltas:

Include several coastal landforms such as tidal flats, low tundra areas, and channel complexes that are found at the seaward terminus of rivers; on the main portion of the Mackenzie River delta, coastal retreat is rapid (>2 m/yr).

Estuaries/Embayments:

May include all of the above-mentioned coastal types with the common attribute that they all occur in very low wave energy environments (wave fetch less than 10 km) and are likely to have lengthy potential residence periods. Limited space precludes mapping individual coastal types within an estuary. Estuaries associated with major rivers are predominantly deltas. Examples are the Wood, Mason, Running, and Babbage Rivers which are marked only as Estuaries on the maps.

Net Longshore Sediment Transport

This information is intended only as a guide to where sediment transport is likely to occur and, on average, in which direction. Net directions are determined from geomorpholog-

ical indicators, such as elongated spits, and aerial photo interpretation. Most longshore transport is due to breaking waves and occurs in water depths from less than 4 m to 5 m. Short term, high energy storm events are responsible for most coastal sediment transport in the Beaufort Sea (4).

Areas Inundated During Positive Storm Surges

The natural tidal range in the southern Beaufort Sea is between 0.3 and 0.5 m. Much greater water level variations are associated with wind driven pile-ups of water in shallow water areas and are called storm surges. Between the years 1962 and 1973, there were 5 negative surges (offshore winds leading to a drop in sea level by up to 1 m) and 22 positive surges (onshore winds leading to a rise in sea level of up to 3 m). The frequency of storm surges is greater during good ice years when sufficient fetch is available to generate the necessary wind driven waves. Positive storm surge events cause extreme coastal erosion and inland flooding of low lying areas, such as Ellice Island (5). The historical limits of storm surge inundation are indicated by log and driftwood debris lines mapped from aerial photographs (6). These lines are used here to delineate the maximum backshore limits of the shoreline sensitivity areas which could be affected by a marine oil spill.

Low Water Line

Shoreline exposed at low tide is mapped (3).

Artificial Islands

These features are abandoned, man-made islands used for oil exploration. Not all islands will be visible as wave action can rapidly erode an island to a level several metres below sea level.

Anchorage

Anchorage described in the Sailing Directions, Arctic Canada (7) are noted.

Shore Access

Arrows denote known locations of shallow draft barge access for direct cargo transfers to and from a beach or shoreline area (7). Note: Winter ice roads are mapped on Regional Maps 4 West and 4 East.

Airstrips

Locations of all existing land airstrips and selected ice runways used in the past are based on information provided by the Canadian Armed Forces Northern Region (Air). Each land site is marked by a particular aircraft symbol to indicate the approximate runway length and condition as follows:

Twin Otter Symbol:

Indicates runways less than 800 m (2,600 ft) or abandoned strips suitable for light aircraft or STOL aircraft in the 6,000 kg weight category and up (Twin Otter, Dash 7, Buffalo). Surface conditions may vary from tundra to sand or gravel. Any symbol marked Aband(oned) should be considered suitable only for Twin Otter aircraft on high flotation tyres until further inspection.

Fokker (Fairchild) F.27 (F227) Symbol:

Indicates primarily Distant Early Warning (DEW) runways approximately 1,100 m (3,600 ft) in length designed specifically to accommodate F27 type aircraft used for routine DEW resupply (also suitable for Hawker Siddely HS 748 as used in the Baffin Region of the NWT). Note: Permission is required to use DEW facilities. Contact Canadian Armed Forces (Air), Northern Region Headquarters, Yellowknife. The DEW Line will be referred to as the North Warning System in the future. Radar and communications equipment are in the process of being upgraded.

Lockheed Hercules (CC130) Symbol:

Indicates runways in excess of 1,500 m (5,000 ft) able to accommodate a heavy lift freight aircraft (Hercules, Electra, B737). The only land airfield in the study region that this applies to is at Tuktoyaktuk.

Ice Runways:

A circled aircraft symbol is used to denote those sites where ice runways have been used for regular operation in the past. Symbols are not meant to imply that these are the only sites available for ice landing. Given suitable conditions (smoothness, snow, ice thickness) there is no physical limit on the size of aircraft that can be accommodated throughout the nearshore area of the study region within the landfast ice zone. Winter fixed wing operations are also possible within the transition ice zone and the polar pack. Operations in these rougher ice areas are usually limited to Twin Otters on skis or large tyre/ski combination undercarriages (see Regional Maps 4 West and 4 East for locations of ice zones and information relating to ice bearing capacity for aircraft operations).

Inlet Widths

Inlet widths are from the 1986 1:150,000 Canadian Hydrographic Service charts for the Beaufort Sea (3).

Temporary Debris Storage Sites and Permanent Disposal Sites

Potential disposal sites are identified for the temporary stockpiling and permanent disposal of oiled debris and sediments. The sites were first selected by previous researchers (8) based mainly on geotechnical considerations, and identified largely through air-photo interpretation. An attempt was made to identify sites as close as possible to sand and gravel beaches that would be cleaned in the event of a spill. The main criteria for permanent disposal site selection are acceptable geological conditions, and that the sites are inland of the maximum storm surge zone and accessible from the shoreline via summer or winter access roads. As some sites cannot be accessed during summer, temporary stockpile locations are also identified at which debris could be temporarily stored before ultimate disposal. In this atlas, some potential sites of each type were rejected for reasons of proximity to archaeological sites, regional camps, and heritage sites. It is accepted that field verification at the time of a spill will be required to confirm site acceptability, and that other considerations, such as proximity to other human-use areas, might preclude the use of certain sites. Nonetheless, inclusion of potential sites in the atlas is considered useful as a tool for countermeasures planning.

Summer and Winter Access (Disposal Sites)

Where possible, summer access is identified to permanent disposal sites, otherwise summer access is identified to temporary storage sites. Temporary sites can be used until winter access over frozen tundra or frozen lakes permits access to permanent disposal sites.

Hydrographic Charts

Current charts at 1:150,000 are available from the Canadian Hydrographic Service (CHS). Note: Although the operational maps in this atlas have been computer generated directly from the CHS digital chart data base, many important navigational features (buoys, beacons, markers, etc.) have not been included. **Maps in this atlas should not be used for navigational purposes and are not intended as substitutes for the original charts.**

Video Tapes

Tape numbers refer to codes for a series of video tapes of the Beaufort Sea coast available through two sources: Dome Petroleum Limited, Calgary, and Atlantic Geoscience Centre (AGC), Geological Survey of Canada, Dartmouth.

Access and Countermeasures

Access and countermeasures information is specific for each operational and tactical map.

References

References are indicated by numbers in brackets (see Sections 5.2 and 5.3 for references relating to Physical Environment and Access and Countermeasures, respectively).

ENVIRONMENTAL SENSITIVITY MAPS

USERS' GUIDE

Legend

Shoreline Environmental Sensitivity*

-  **High Sensitivity Ranking > 68.70**
-  **Moderate Sensitivity Ranking 35.10 - 68.70**
-  **Low Sensitivity Ranking < 35.10**

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

50	Nicholson Island	21.25
51	Cliff Point	20.50
52	Anderson River	102.30
62	Mason River	64.45

-  **Archaeological Site**
-  **Heritage Site - locally identified**
-  **Major Resource Harvesting Camp**
-  **Other Resource Harvesting Camp**
-  **National or Territorial Park**

Resource Harvesting Areas



Highly Important R



Important R

Birds



Diving Ducks & Loons DL



Dabbling Ducks DD



Geese Ge



Swans Sw



Shorebirds & Cranes SC



Seabirds Se

Mammals



White Whale WW



Bowhead Whale Bh



Polar Bear PB



Ringed Seal RS



Bearded Seal BS



Arctic Fox AF



Reindeer Re or Caribou Ca

Fish



Anadromous Fish & Pacific Herring F

Site Specific

Environmental Sensitivity

Appendix A provides the background information and the detailed rankings necessary to interpret the summary values and relative sensitivity rankings (High, Moderate, Low) shown on the maps. The entire study area is divided into sensitivity areas. There are 69 shoreline environmental sensitivity areas shown on the operational maps. Shoreline area boundaries extend from approximately 1 km offshore to the maximum extent of storm surges in the backshore.

Environmental sensitivity areas for the offshore were determined separately for the winter/spring and summer/fall periods by using ice and open water zones to define the area boundaries. Sensitivity was determined for 15 offshore areas during winter/spring and 11 areas for summer/fall. Offshore environmental sensitivities are shown on Summary Maps 3 and 4 and Regional Maps 1 West, 1 East, 2 West, and 2 East.

Seasons

The following seasonal definitions apply throughout the Atlas:

Shoreline Sensitivity (Summer/Fall)

- refers to the period late May to October 1, which corresponds to the maximum time span when oil could be exposed in an unfrozen state along the shore. It should be noted that there will be no opportunity for fresh oil to reach the shoreline from a marine spill until landfast ice break-up in early July.

Offshore Sensitivity (Summer/Fall)

- refers to the period July 17 to October 1, which corresponds to the duration of significant open water extent offshore. The variability in ice clearing dates throughout the study area is shown in Summary Map 9.

Offshore Sensitivity (Winter/Spring)

- refers to the period October 2 to July 16, which corresponds to the duration of extensive ice cover.

Archaeological Sites were identified from the Archaeological Survey of Canada (ASC) inventory and are shown on the operational maps. In the event of an oil spill, the ASC should be contacted for information on the contents and status of these sites.

Heritage Sites are those areas that Inuvik workshop participants identified as having the greatest cultural or historic significance to local residents (shown only on the operational maps).

Major Resource Harvesting Camps are locations that are used every year as a base for resource harvesting activities and are considered of primary importance by regional residents (shown only on the operational maps).

Other Resource Harvesting Camps are locations that often serve as a fishing or hunting camp or as a temporary camp in bad weather. These camps have only been identified within areas considered to be important for resource harvesting by regional residents (shown only on the operational maps).

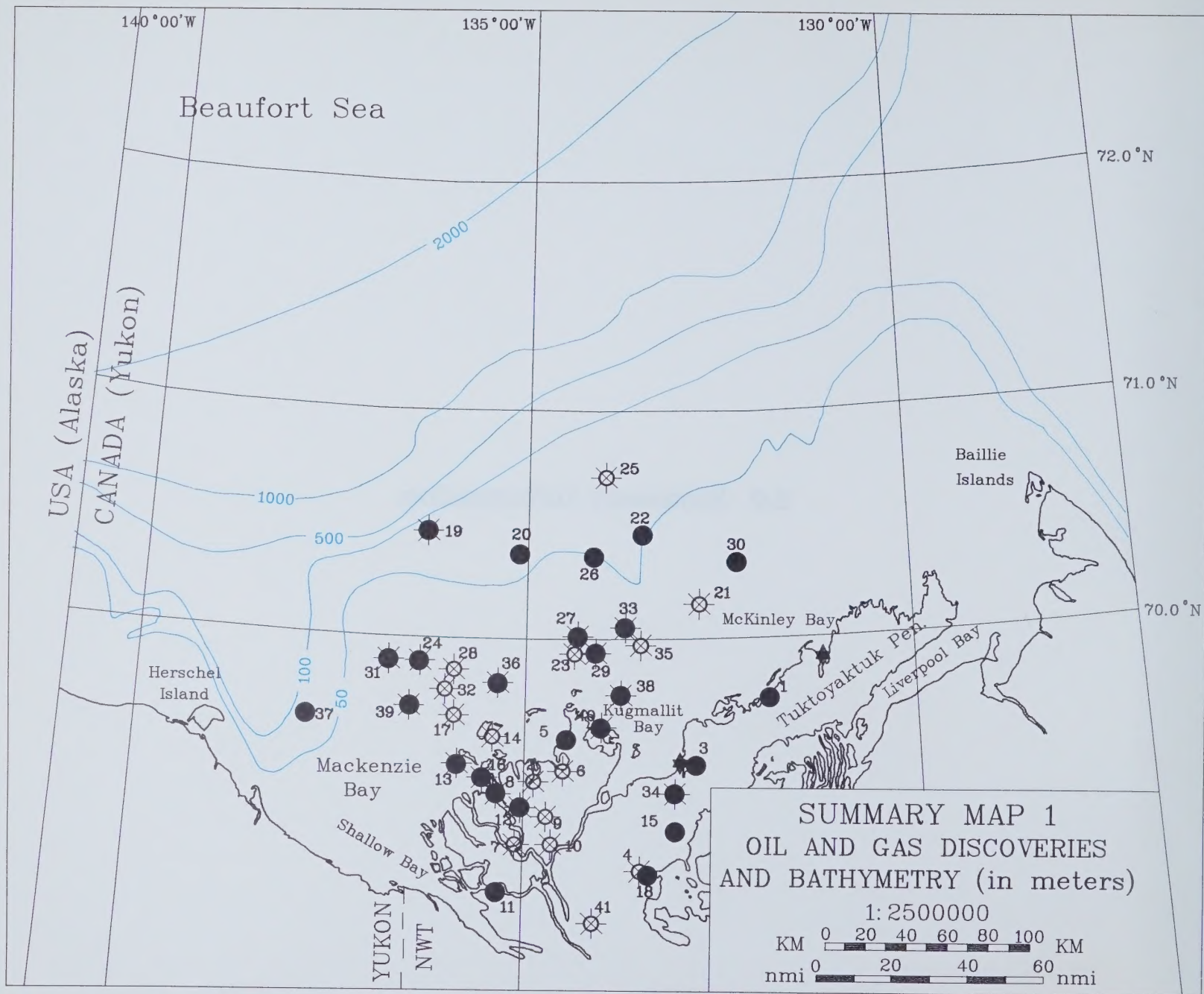
National or Territorial Park Boundaries are shown on the operational maps and Summary Map 5.

Black Animal Symbols on the regional and operational maps indicate the general area where: (1) a significant proportion of a regional population; (2) a significant proportion of a group of bird species; (3) an important resource harvesting area; or (4) a large number of important fish species occurs. Fewer numbers of these species or other harvesting activities may occur in other areas, but symbols have been placed only where significant numbers of individuals have been observed over a period of several years or in areas that were identified by workshop participants as being important for resource harvesting. See Appendix A for detailed information.

Coloured Symbols on the regional and operational maps indicate a very site-specific area (less than approximately 50 km²) that is used by a significant proportion of a regional population.

References are indicated by numbers in brackets (see Sections 5.4 and 5.5 for references relating to Offshore Environmental Sensitivity and Shoreline Environmental Sensitivity, respectively).

2.0 Summary Information



OIL & GAS DISCOVERIES & BATHYMETRY

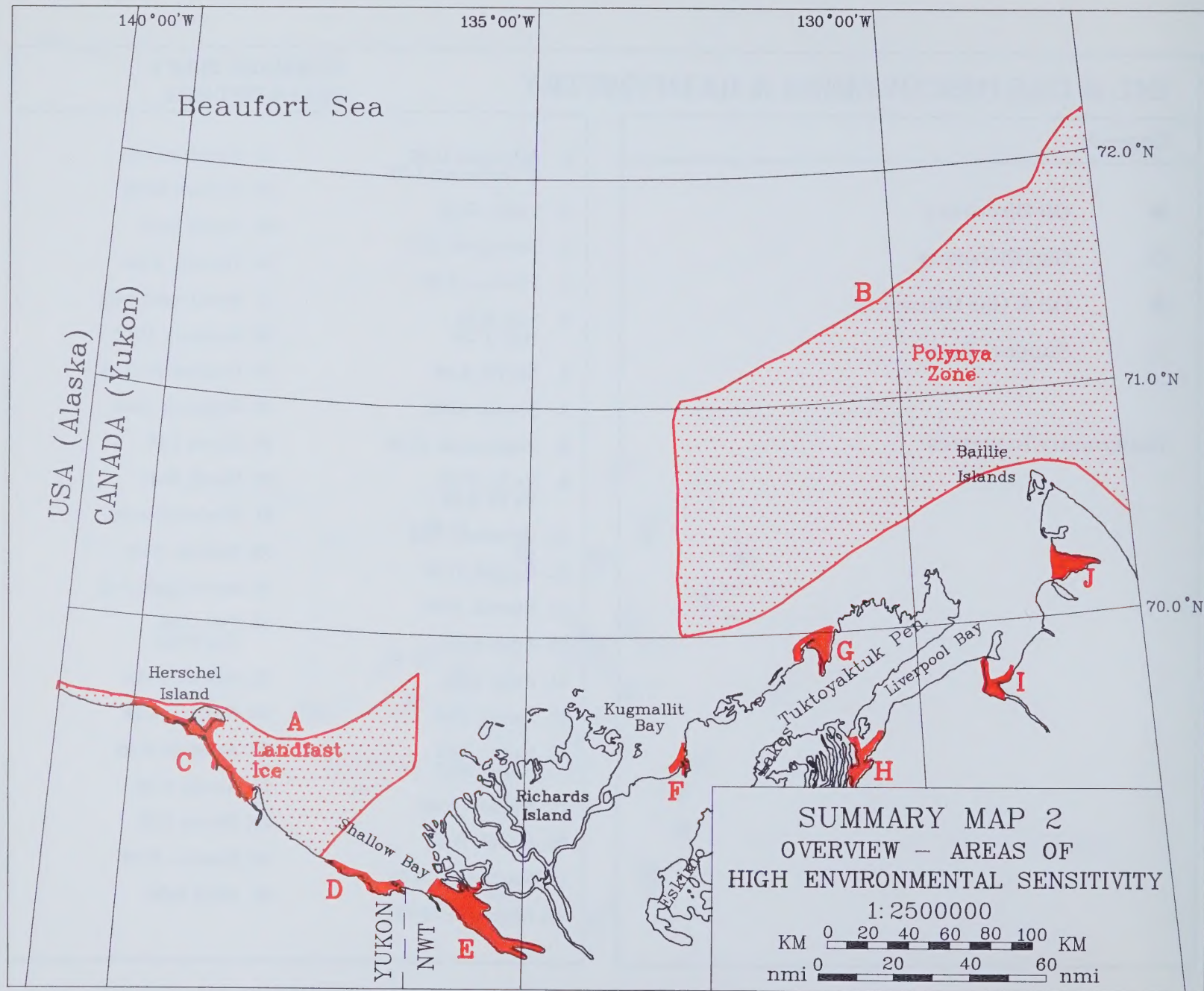
SUMMARY MAP 1 BEAUFORT SEA

Legend

- Oil Discovery
- ☼ Gas Discovery
- ☼ Oil & Gas Discovery
- ★ Support Base

Bathymetry in metres

- | | |
|--------------------------------------|--------------------------|
| 1. Atkinson H-25
W. Atkinson L-17 | 21. Ukalerk C-50 |
| 2. Taglu G-33 | 22. Nerlerk M-98 |
| 3. Mayogiak J-17 | 23. Isserk E-27 |
| 4. Parsons F-09 | 24. Tarsuit A-25 |
| 5. Ivik K-54
Ivik J-26 | 25. Kenalooak J-94 |
| 6. Mallik A-06 | 26. Koakoak O-22 |
| 7. Titalik K-26 | 27. Issungnak O-61 |
| 8. Niglintgak H-30 | 28. Kiggavik A-43 |
| 9. Ya Ya P-53
Ya Ya A-08 | 29. Itiyok I-27 |
| 10. Reindeer F-36 | 30. Havik B-41 |
| 11. Kugpik O-13 | 31. Pitsiulak A-05 |
| 12. Kumak J-06 | 32. Kadluk O-07 |
| 13. Adgo F-28 | 33. Amauligak J-44 |
| 14. Pelly B-35 | 34. Tuk J-29
Tuk M-09 |
| 15. Imnak J-29 | 35. Amerk O-09 |
| 16. Garry P-04
Garry G-07 | 36. Nipterk L-19 |
| 17. Netserk F-40 | 37. Adlartok P-09 |
| 18. Kamik D-48 | 38. Arnak K-06 |
| 19. Nektoralik K-59 | 39. Minuk I-53 |
| 20. Kopanoar M-13 | 40. Hansen G-07 |
| | 41. Ikhil N-35 |



OVERVIEW – AREAS OF HIGH ENVIRONMENTAL SENSITIVITY

SUMMARY MAP 2 BEAUFORT SEA

INTRODUCTION

This map presents a summary of areas of high environmental sensitivity to oil spills based on available data and the environmental sensitivity ranking scheme described in Appendix A. Depending on actual environmental conditions at the time of a spill, other areas may be more or less sensitive than those shown here. A number of areas ranked six points or less below the range defining the "High" category are not indicated on this map. These "borderline" areas are Kendall Island (Area No. 24), Kittigazuit Bay (Area No. 34), Hutchison Bay (Area No. 41), and Mason River (Area No. 62).

Users should refer to detailed information regarding the human use, biological, and physical environmental factors that contribute to the sensitivity of all areas before deciding on a response plan. This information is provided on the maps and accompanying text throughout the atlas. Appendix A contains a complete list of the environmental elements for each sensitivity area, sensitivity ranking calculations, and a full explanation of the sensitivity ranking scheme.

A summary of the environmental elements that contribute to the high sensitivity of the areas shown on Summary Map 2 is presented below.

A. Landfast Ice off the Yukon Coast During Winter/Spring (October 2 to July 16)

See Regional Map 1 West, Environmental Sensitivity Area 209

- Black guillemots (a rare and endangered bird) breed, rear broods, feed, moult and rest in and adjacent to nearshore waters northeast of Herschel Island.
- Polar bears and seals are hunted on the landfast ice between Phillips Bay and Herschel Island.
- White whales travel along the landfast ice edge to Mackenzie Bay and Kugmallit Bay.

- Marine fish overwinter under ice, and anadromous species migrate along the coast in spring.
- Oil spilled in landfast ice after freeze-up in early October will be quickly incorporated within the growing ice and remain encapsulated until the following spring when the oil will migrate to the surface and be exposed as slicks on melt pools from late May to ice break-up in July.
- The time period when the simultaneous occurrence of most of these elements may occur is late May through mid July.

B. Polynya Zone off Tuktoyaktuk Peninsula and Baillie Islands During Winter/Spring (October 2 to July 16)

See Regional Map 1 East, Environmental Sensitivity Areas 207 and 208

- Polar bears are hunted from mid January to the end of May.
- Several thousand diving ducks congregate in leads from mid May until early June.
- Substantial numbers of polar bears occupy areas in the transition zone.
- Bearded seals are abundant in the transition zone and pup in April and May.
- White whales travel along the landfast ice edge to concentration areas in Kugmallit and Mackenzie Bays.
- Oil in the polynya zone could be available for exposure to wildlife at any time during the winter.
- Increasing opportunity for oil exposure will be associated with the typical progression of polynya expansion from the Baillie Islands to the north and west beginning in March (see Figures 1 and 2, Summary Map 7).
- Simultaneous occurrence of most of these elements is most likely to occur from mid May to the end of May.

C. Yukon Coast from Nunaluk Spit to Phillips Bay, late May to October 1

See Operational Maps 2, 3 and 4, Environmental Sensitivity Areas 4,6, 8, 9, 10 and 11

- . A number of human use elements contribute to the sensitivity of this area. These include resource harvesting, heritage sites, camps, archaeological sites and parks.
- . Diving ducks, shorebirds, black guillemots and brant use various coastal areas in this region during the period May to September.
- . Use of the region by Arctic foxes and caribou contribute to the sensitivity.
- . Nearshore areas provide important migration corridors for anadromous fish and feeding and rearing habitat for marine and anadromous species.
- . Estuary/embayment shore zone types are common along this coast and have the highest oil retention capacity.

D. Trent Bay and Shoalwater Bay, late May to October 1

See Operational Maps 5 and 6, Environmental Sensitivity Areas 16 and 17

- . Regional residents indicated that these areas were of greatest importance for resource harvesting.
- . Glaucous gulls breed and rear broods on Escape Reef and swans and geese use coastal areas from Trent Bay to the mouth of West Channel.
- . White whales concentrate in Shoalwater Bay during late June to mid July.
- . Nearshore areas are important for summer feeding, migration and rearing for fish.
- . Caribou use nearshore areas to feed during mid June.

E. Shallow Bay, late May to October 1

See Operational Maps 7 and 8, Environmental Sensitivity Areas 19 and 20

- . Whale and bird hunting occurs in these areas.
- . Swans and geese (including brant) use Shallow Bay and adjacent wetlands and river channels.
- . Mackenzie River channels are important migration corridors for fish. Some fish may overwinter where there is flow under ice.
- . Estuary/embayment shore zone type in Shallow Bay have the highest oil retention capacity.

F. Tuktoyaktuk, late May to October 1

See Operational Maps 14 and 15, Environmental Sensitivity Area 37

- . Tuktoyaktuk is the only community located within the study area and is an important base for many harvesting activities.
- . Tuktoyaktuk Harbour provides an important year-round fish habitat.
- . Archaeological sites and the Pingo Landmark Site contribute to the sensitivity of the area.
- . Estuary/embayment shore zone type is predominant in this region and has a high oil retention capacity.

G. McKinley Bay and Atkinson Point, late May to October 1

See Operational Maps 17 and 18, Environmental Sensitivity Area 43

- . This area is important for residents of Tuktoyaktuk throughout the year. There are also a number of archaeological sites and a heritage site located in the area.
- . Diving ducks and brant moult and stage in the McKinley Bay area. The latter species also nests and rears broods in this area.
- . Nearshore areas provide summer rearing and feeding habitat

and are important migration corridors for fish.

Reindeer use nearshore areas to escape from flies from late July to early September.

Estuary/embayment is the predominant shore zone type and it has a high oil retention capacity.

H. Entrance to Eskimo Lakes and Kugaluk River, late May to October 1

See Operational Maps 22 and 22A, Environmental Sensitivity Areas 57, 58 and 59

This is an important spring and summer resource harvesting area. There are also a number of archaeological sites located along the coast.

Large numbers of birds (swans, diving ducks and brant) use these areas.

Pacific herring spawn in shoreline areas during spring. The Kugaluk River supports large populations of anadromous coregonids.

Caribou use some nearshore areas to escape from flies during July.

Shore zone types vary, but near the Kugaluk River the predominant type is estuary/embayment.

I. Wood Bay and Anderson River Delta, late May to October 1

See Operational Map 23, Environmental Sensitivity Area 52

This area is important to residents of Tuktoyaktuk, and a camp is often established in the area for resource harvesting. Several archaeological sites and a heritage site are located in the area.

This area is used by thousands of birds including diving ducks, dabbling ducks, swans and geese. The most recent confirmed sighting of an Eskimo curlew occurred in this area.

Nearshore habitat is important for anadromous fish from the Anderson River.

Caribou use nearshore areas to escape from flies during July.

J. Harrowby Bay, late May to October 1

See Operational Map 25, Environmental Sensitivity Area 65

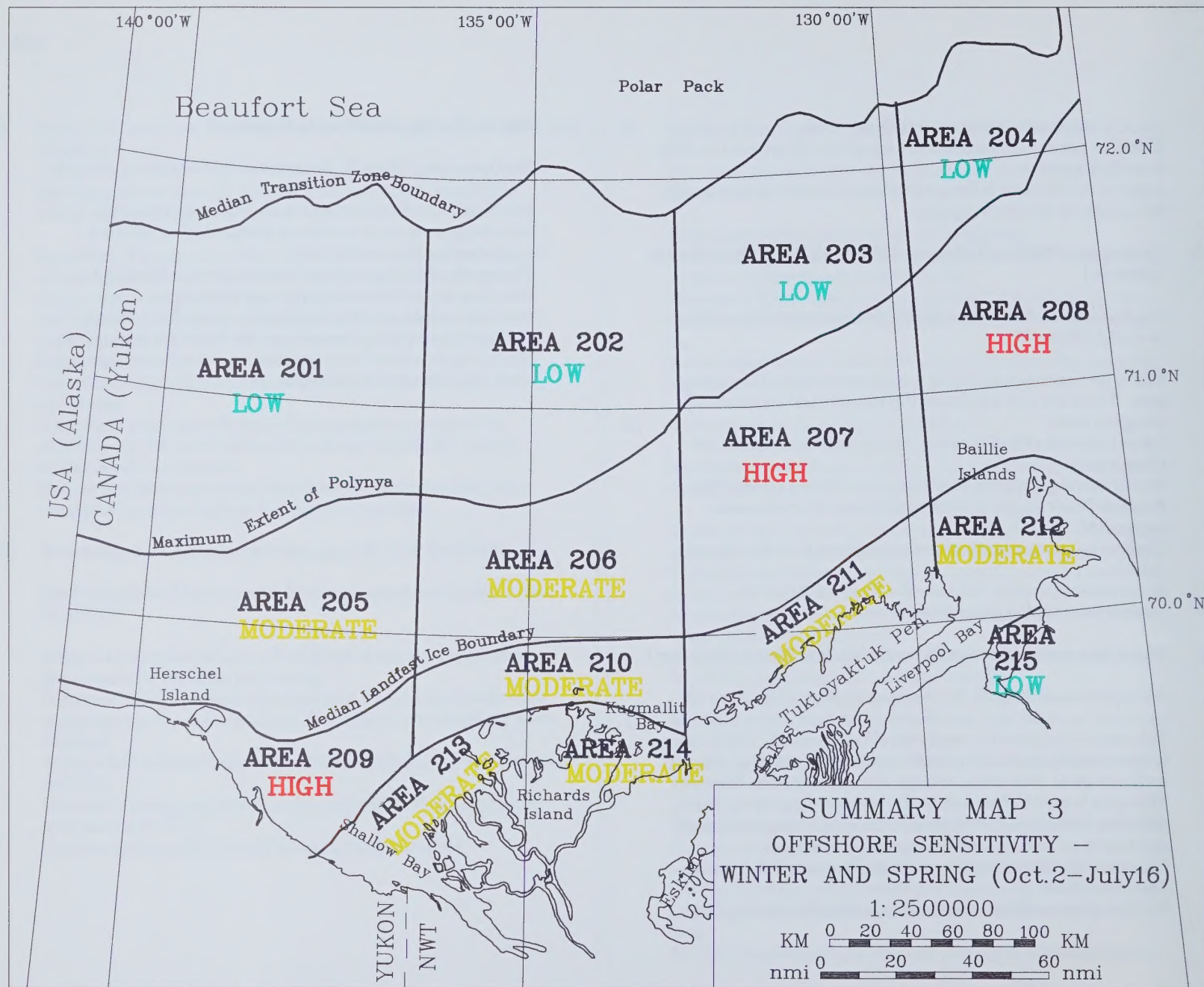
The North Star Harbour area is an important resource harvesting area and a number of archaeological sites are located on the shore of the bay.

Thousands of diving ducks and geese use nearshore and shoreline areas from mid July to mid September.

Nearshore areas provide important summer fish habitat.

Caribou use nearshore areas to escape from flies during July.

Estuary/embayment is the predominant shore zone type and it has a high oil retention capacity.



OFFSHORE ENVIRONMENTAL SENSITIVITY - WINTER AND SPRING

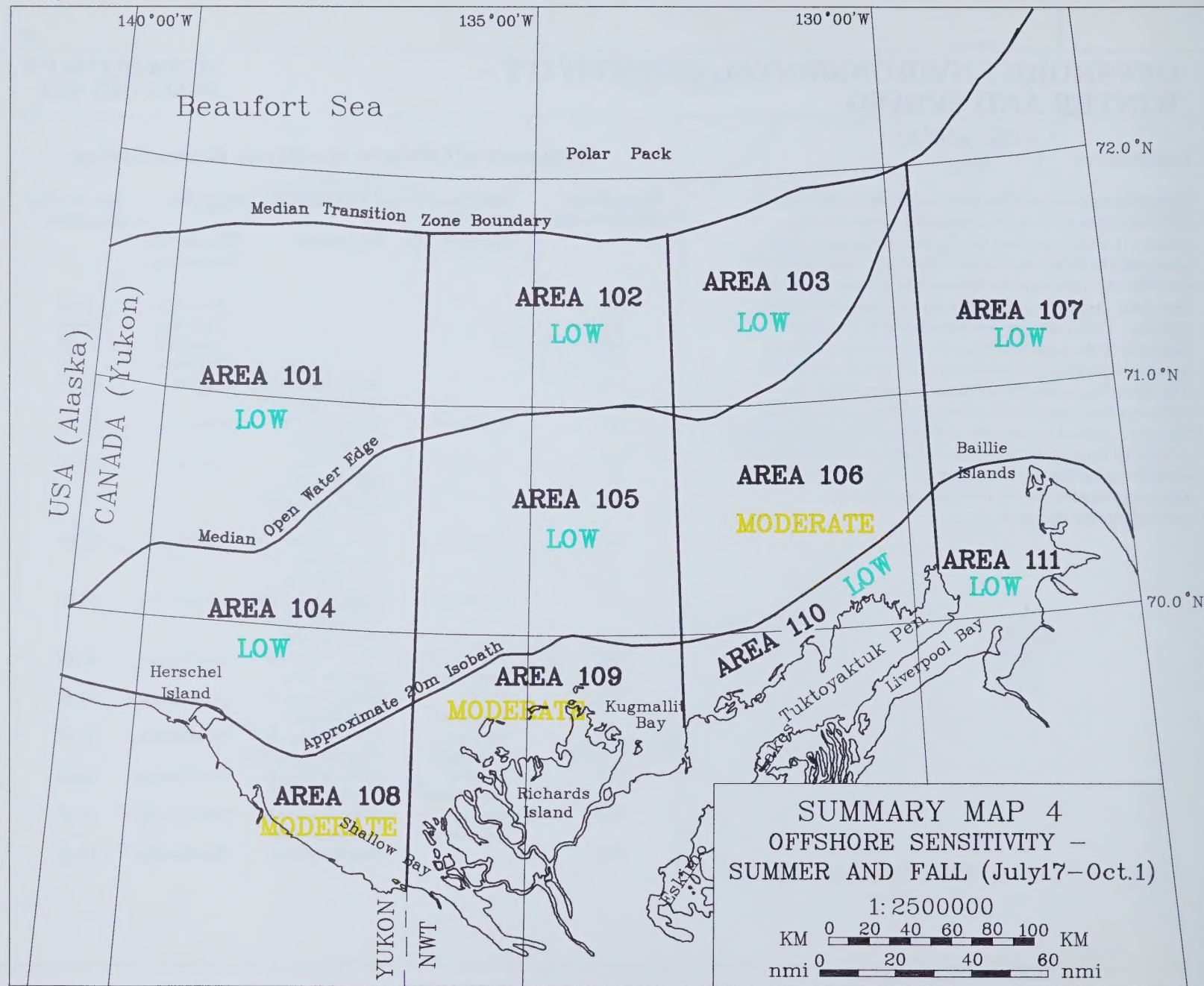
SUMMARY MAP 3 BEAUFORT SEA

Introduction

This map summarizes the environmental sensitivity of offshore areas to oil spills during the winter/spring period. It also illustrates the ice zone boundaries that were used to define the sensitivity areas. Appendix A provides the rationale for delineation of these zones and describes the marine oil residence category used in the ranking. This category was developed to provide an estimate of the length of time oil would be available for exposure to biological resources and human activities. The following table summarizes the environmental elements that contribute to the sensitivity of each area. However, users should refer to Regional Maps 1 West and 1 East for detailed information regarding environmental sensitivity for the winter/spring period and Appendix A for an explanation of the ranking scheme and environmental elements.

Summary of Offshore Sensitivity Winter/Spring

Sensitivity Area Number	Environmental Sensitivity Categories			Sensitivity Ranking
	Human Use	Biological	Marine Oil Residence	
201	--	--	Transition	7.50
202	--	--	Transition	7.50
203	--	--	Transition	7.50
204	--	--	Transition	7.50
205	--	Black Guillemots & Polar Bears	Polynya	40.25
206	Important	Polar Bears & White Whales	Polynya	45.25
207	Important	Diving Ducks, Polar Bears, Bearded Seals & White Whales	Polynya	73.25
208	Important	Diving Ducks, Bearded Seals & White Whales	Polynya	61.00
209	Important	Black Guillemots, White Whales & Offshore Fish	Landfast Ice	54.75
210	Highly Important	White Whales & Offshore Fish	Landfast Ice	41.25
211	Highly Important	Diving Ducks & Offshore Fish	Landfast Ice	46.50
212	Highly Important	Diving Ducks & Offshore Fish	Landfast Ice	46.50
213	Greatest Importance	White Whales & Nearshore Fish	Overflooding	45.50
214	Greatest Importance	White Whales & Nearshore Fish	Overflooding	45.50
215	--	Nearshore Fish	Overflooding	15.00



OFFSHORE ENVIRONMENTAL SENSITIVITY – SUMMER AND FALL

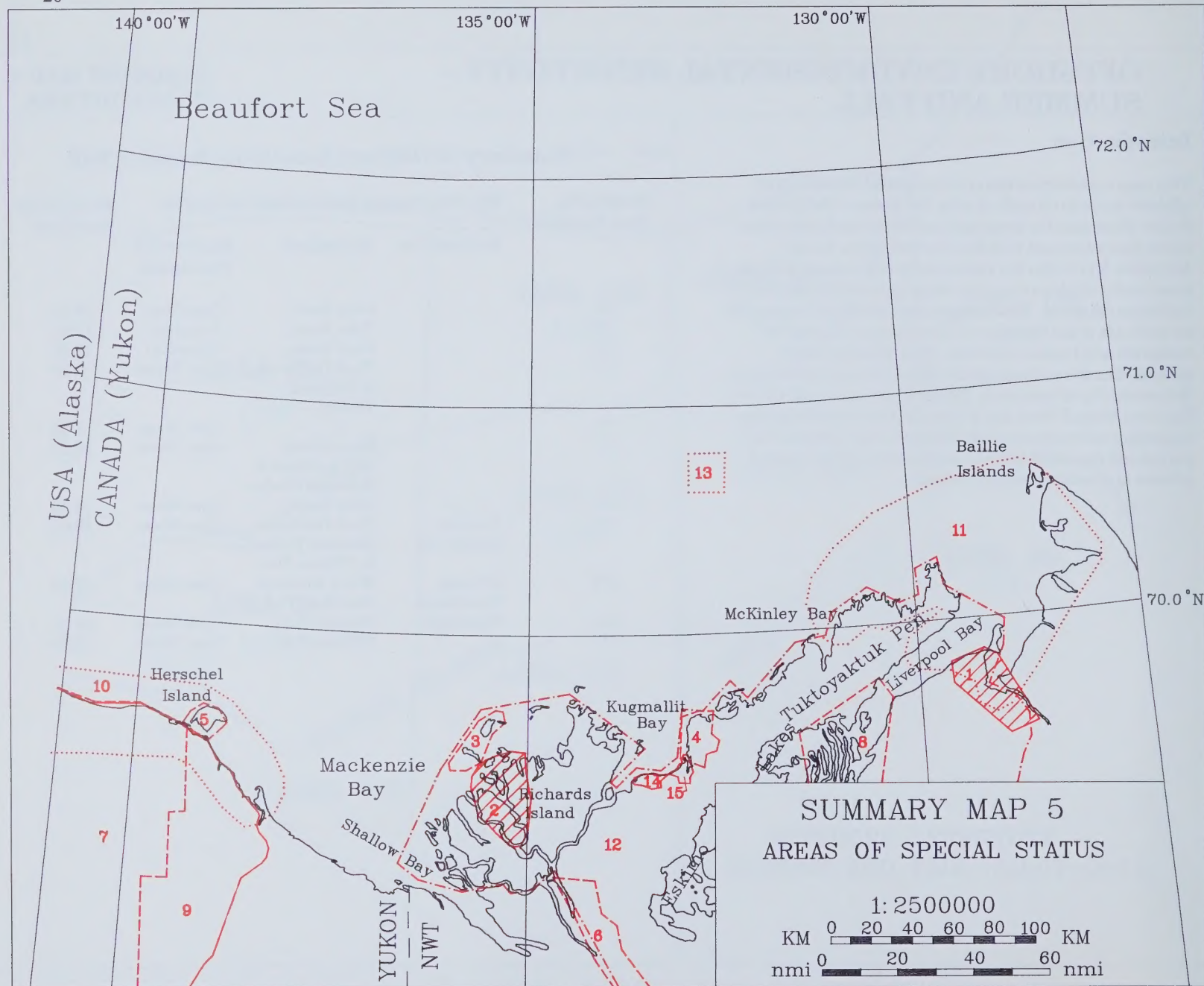
SUMMARY MAP 4 BEAUFORT SEA

Introduction

This map summarizes the environmental sensitivity of offshore areas to oil spills during the summer/fall period. It also illustrates the boundaries of the ice and open water zones that were used to define the sensitivity areas. Appendix A provides the rationale for delineation of these zones and includes a complete description of the marine oil residence category. This category was developed to provide an estimate of the duration of oil exposure to biological resources and human activities. The following table summarizes the environmental elements that contribute to the sensitivity of each area. However, users should refer to Regional Maps 2 West and 2 East for detailed information regarding environmental sensitivity for the summer/fall period and Appendix A for an explanation of the ranking scheme and environmental elements.

Summary of Offshore Sensitivity Summer/Fall

Sensitivity Area Number	Environmental Sensitivity Categories			Sensitivity Ranking
	Human Use	Biological	Marine Oil Residence	
101	--	Polar Bears	Transition	18.25
102	--	Polar Bears	Transition	18.25
103	--	Polar Bears	Transition	18.25
104	--	Black Guillemots & Bowhead Whales	Open Water	31.25
105	--	--	Open Water	1.50
106	--	Ringed Seals, Bearded Seals & Bowhead Whales	Open Water	38.25
107	--	Polar Bears	Open Water	13.75
108	Greatest Importance	Black Guillemots, Bowhead Whales & Offshore Fish	Open Water	60.00
109	Greatest Importance	White Whales & Nearshore Fish	Open Water	42.50
110	Important	Offshore Fish	Open Water	22.25
111	--	Offshore Fish	Open Water	10.25



AREAS OF SPECIAL STATUS

SUMMARY MAP 5 BEAUFORT SEA

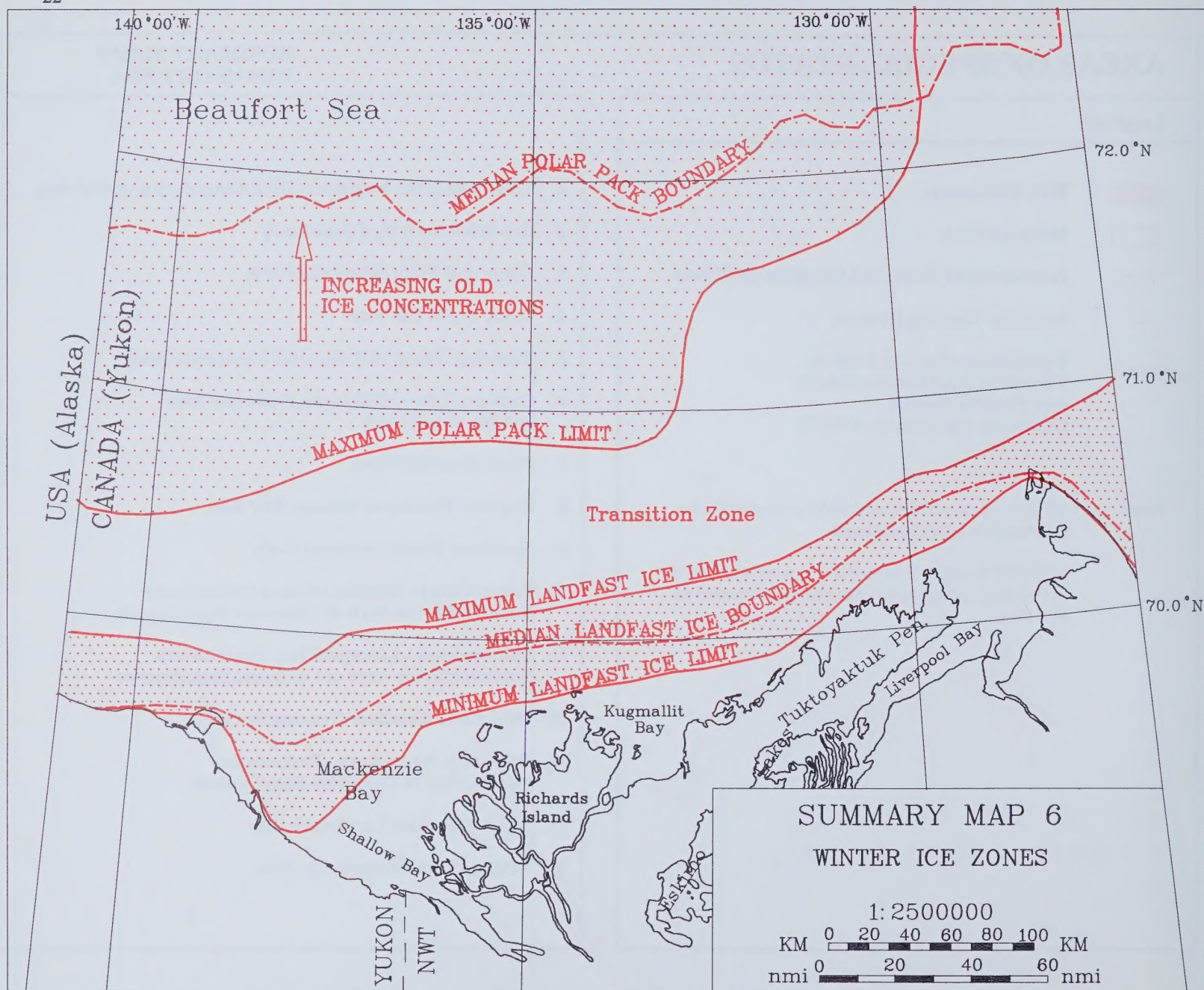
Legend

-  Bird Sanctuary
-  National Park
-  International Biological Program (IBP) Site
-  Reindeer Grazing Reserve
-  Preliminary Natural Areas of Canadian Significance (NACS) and Natural Sites of Canadian Significance (NSCS)

Note: [1] Boundaries of National and Territorial Parks indicated on operational maps.

[2] COPE Lands are located along most of the coast in the study area, but have not been delineated on this map.

1. Anderson River Migratory Bird Sanctuary and IBP Site
2. Kendall Island Bird Sanctuary
3. Garry and Pelly Islands IBP Site
4. Toker Point IBP Site
5. Herschel Island IBP Site and Territorial Park
6. Caribou Hills – Mackenzie Delta IBP Site and Proposed Park
7. Firth River IBP Site
8. Kugaluk River and Estuary IBP Site
9. Northern Yukon National Park
10. Yukon Coast – Herschel Island Preliminary Natural Marine Area of Canadian Significance
11. Tuktoyaktuk – Liverpool Bay Preliminary Natural Marine Area of Canadian Significance
12. Mackenzie Reindeer Grazing Reserve
13. Kugmallit Pingo Area – Preliminary Natural Site of Canadian Significance
14. Pingo Canadian Landmark Site
15. Tuktoyaktuk Community Site



WINTER ICE ZONES

SUMMARY MAP 6 BEAUFORT SEA

Legend



Range in Seaward Landfast Ice Boundaries observed between January 14 and May 31 from 1970 to 1971 and 1973 to 1983 (1,2,3).



Median Seaward Landfast Ice Boundary between January 14 and May 31 from 1970 to 1971 and 1973 to 1983.



Range in Southern Limit of Polar Pack Boundaries ($\geq 5/10$ old ice) observed between December 31 and May 15 from 1979 to 1985 (1).

Off Map

Minimum Southern Limit of the Polar Pack Boundary ($\geq 5/10$ old ice) between December 31 and May 15 from 1979 to 1985 occurs north of 73° N (1).



Median Southern Polar Pack Boundary ($\geq 5/10$ old ice) between December 31 and May 15 from 1979 to 1985.

The region to the north of the median polar pack boundary was not considered as part of the offshore area ranked for environmental sensitivity. The behaviour of oil trapped in multi-year ice is not well understood. Residence times are likely to be many years, as multi-year ice rarely melts completely in a single season. Exceptions will be unusual situations where old floes advance south and become grounded nearshore (for example, the fall of 1983). For large volumes of oil to become incorporated within the polar pack of the Beaufort Sea, the spill would have to take place in water depths well beyond the limits of existing or proposed arctic drilling or transportation systems.

Access:

Airstrips in this area include those at Tuktoyaktuk, Komakuk Beach, Stokes Point, Trent Bay, Atkinson Point, Nicholson Island and Smoke River. Winter airstrips have been built in previous years on the ice at McKinley Bay, Cape Dalhousie, Komakuk Beach, Herschel Island, and Shingle Point.

In previous years, a winter ice road has been built along the coastline to the east as far as McKinley Bay and to the west as far as Herschel Island. The roads can be used to supply coastal staging points during winter-time, (see Regional Maps 4 West & 4 East).

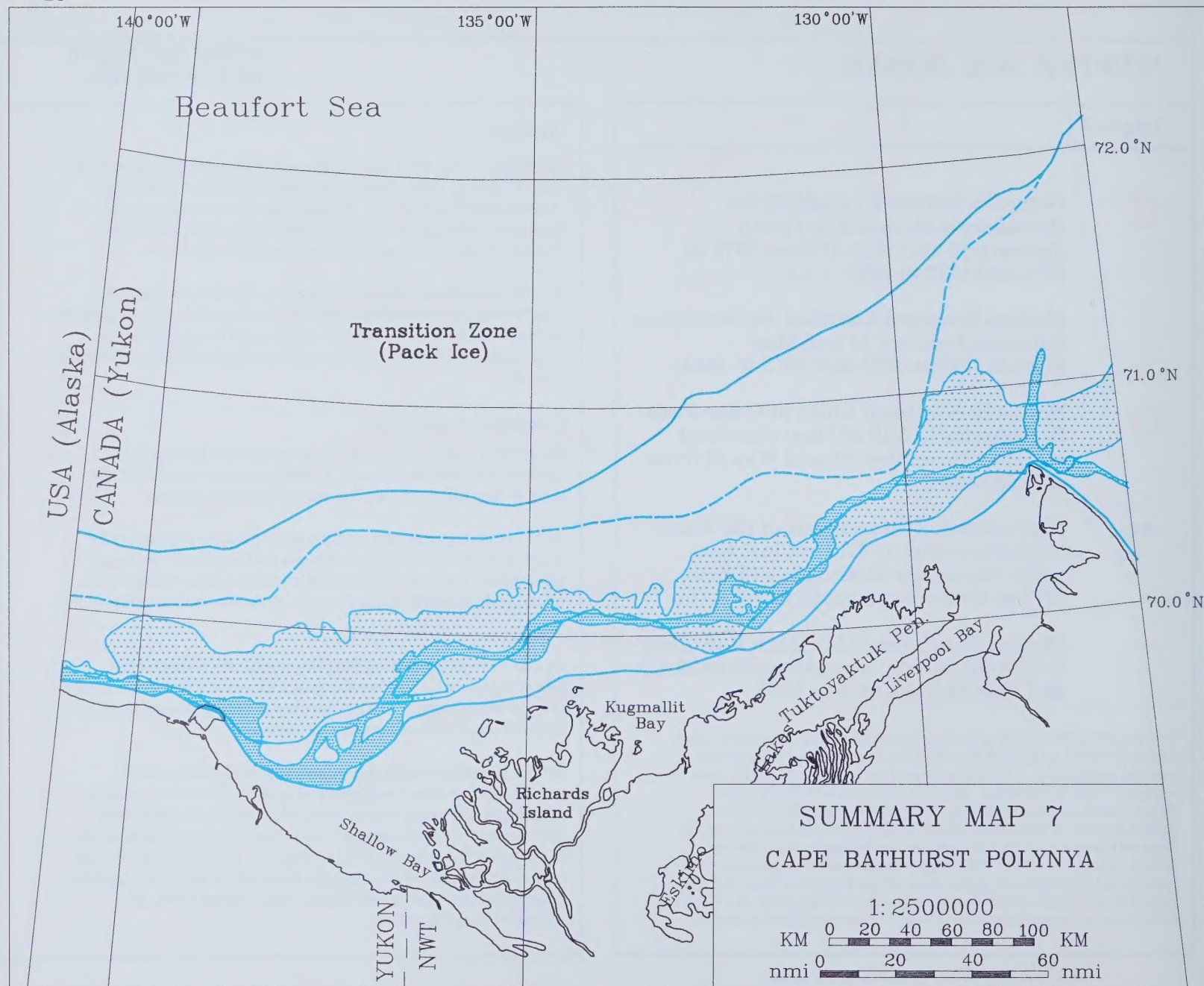
Countermeasures:

Response to spills during winter may involve tracking and surveillance of oiled ice, and, possibly, in-situ burning at the time of the spill or during the succeeding melt season.

An ice tracking program using tracking buoys will generally involve periodic helicopter missions to the spill site for buoy placement. Such missions could involve various coastal landing sites depending on the location, duration, and severity of the spill.

At source in-situ burning may be possible for a short time following the spill. Ice breaking at a blowout site may be used to release blowout gas. In-situ burning may also be applicable to spills in leads and incomplete ice cover.

In-situ burning during the succeeding melt season would require winter-time stockpiling of ignition devices at coastal staging points using winter ice roads. During the following spring, numerous helicopter missions would be required from the staging areas to the oiled melt pools. Considering ice road access and probable proximity to the track of oiled ice, possible staging locations are at McKinley Bay, Stokes Point, and Shingle Point/Trent Bay.



CAPE BATHURST POLYNYA

Legend

-  Flaw Polynya on May 25, 1983 (4).
-  Flaw Polynya on May 21, 1984 (4).
-  Maximum Range of Recurring Polynya and Lead Systems observed for April and May between 1969 and 1984, including May 1979 Polynya (4,5,6,7).
-  Maximum Northern Limit of Recurring Polynya and Lead Systems excluding May 1979 Polynya (4,5,6,7).

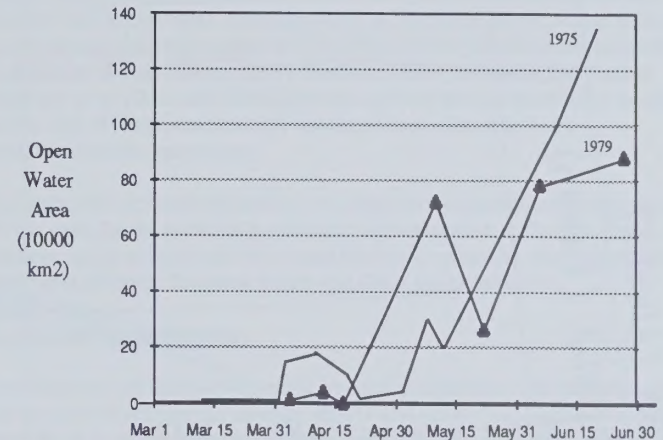
The recurring opening in the ice cover known as the Cape Bathurst Polynya (officially defined as a flaw polynya) is bounded to the south by solid landfast ice and to the north by dynamic ice in the transition zone. The location and extent of open water within the polynya are extremely variable. Depending on regional wind fields, the polynya can open and close over a 24 hour period or less. In general, the polynya is first visible as a distinct lead stretching from Banks Island to Herschel Island as early as March. In April and May this lead usually expands rapidly from east to west. At this time, the area of open water or new ice associated with the polynya can cover a large extent of the offshore area of the Beaufort Sea (Figures 1 and 2).

Map 7 shows two actual outlines of polynyas as they existed in 1983 and 1984, together with a composite envelope representing the maximum range of north/south boundaries of all polynyas mapped over 15 years from a variety of sources (4,5,6,7). This envelope does not indicate that any given polynya will likely encompass the entire area shown, but that openings in the ice cover and **potential oil exposure** during the winter should be considered a possibility anywhere between the blue lines.

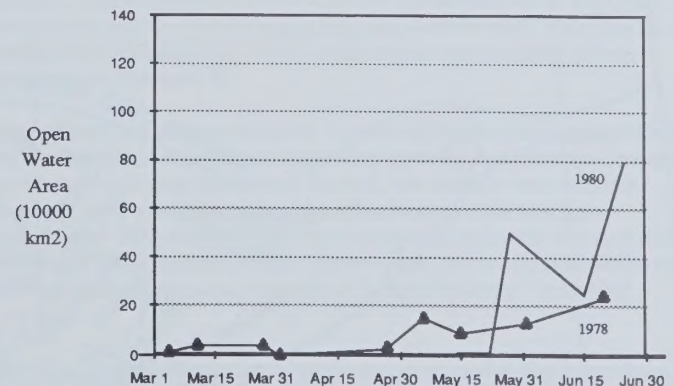
One case stands out as an extreme example of extensive polynya development. A NOAA satellite image of May 6, 1979 showed open water extending as far north as the solid line shown on Map 7. When this 1979 case is excluded, the maximum northerly limit of the historical polynya range retreats to the dotted blue line. The variability in polynya extent should be considered when interpreting the offshore sensitivity area boundaries shown on Summary Map 3. These boundaries were drawn to encompass the absolute limit of historical polynya occurrence.

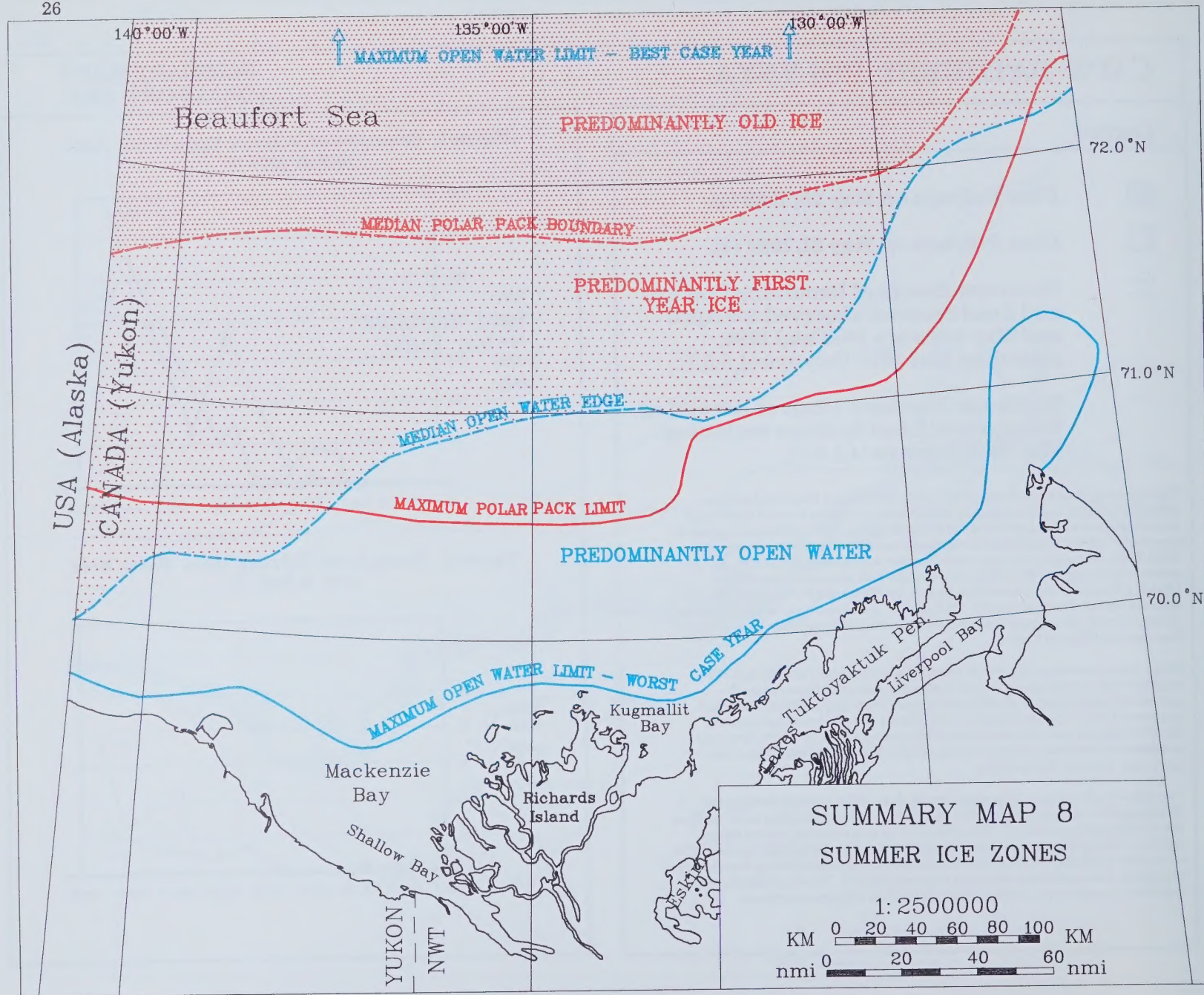
SUMMARY MAP 7 BEAUFORT SEA

**Figure 1. Examples of Polynya Open Water Area
1975 & 1979 (8)**



**Figure 2. Examples of Polynya Open Water Area
1978 & 1980 (8)**





SUMMER ICE ZONES

Legend

-  **Maximum Open Water Limit between July 16 and October 1 from 1969 to 1985, Worst Case Year September 21-26, 1974 (1,5,6).**
- Off Map **Maximum Open Water Limit between July 16 and October 1 from 1969 to 1985, Best Case Year August 17-24, 1977 occurred approx. at 73°N (1,5,6).**
-  **Median Open Water Limit between July 16 and October 1 from 1959 to 1974 (1,5,6).**
-  **Maximum Southern Limit of the Polar Pack ($\geq 5/10$ old ice) between July 16 and October 1 from 1959 to 1985 (1,9).**
- Off Map **Minimum Southern Limit of the Polar Pack ($\geq 5/10$ old ice) between July 16 and October 1 from 1959 to 1985 occurred north of 73°N (1,9).**
-  **Median Southern Limit of the Polar Pack ($\geq 5/10$ old ice) between July 16 and October 1 from 1959 to 1974 (9).**

Note: Area north of the median polar pack is not considered in this atlas (see text note for Summary Map 6).

SUMMARY MAP 8 BEAUFORT SEA

Access:

Protected anchorages for shallow draft vessels are available at various locations along the coast. Pauline Cove, at Herschel Island, offers protection for vessels drawing up to 5 m, and Pelly Island affords some protection in depths to 2.5 m. Tuktoyaktuk Harbour offers protection for vessels drawing up to 4.2 m, and McKinley Bay affords good protection in depths to 9 m. All of these locations are potential bases for nearshore countermeasures operations.

Access points for barge offloading are noted in the operational map series. To the west, barge access is good for all locations west of Shingle Point. To the east, barge access is good in most locations except for the Tuktoyaktuk Peninsula between Nuvorok Point and Cape Dalhousie.

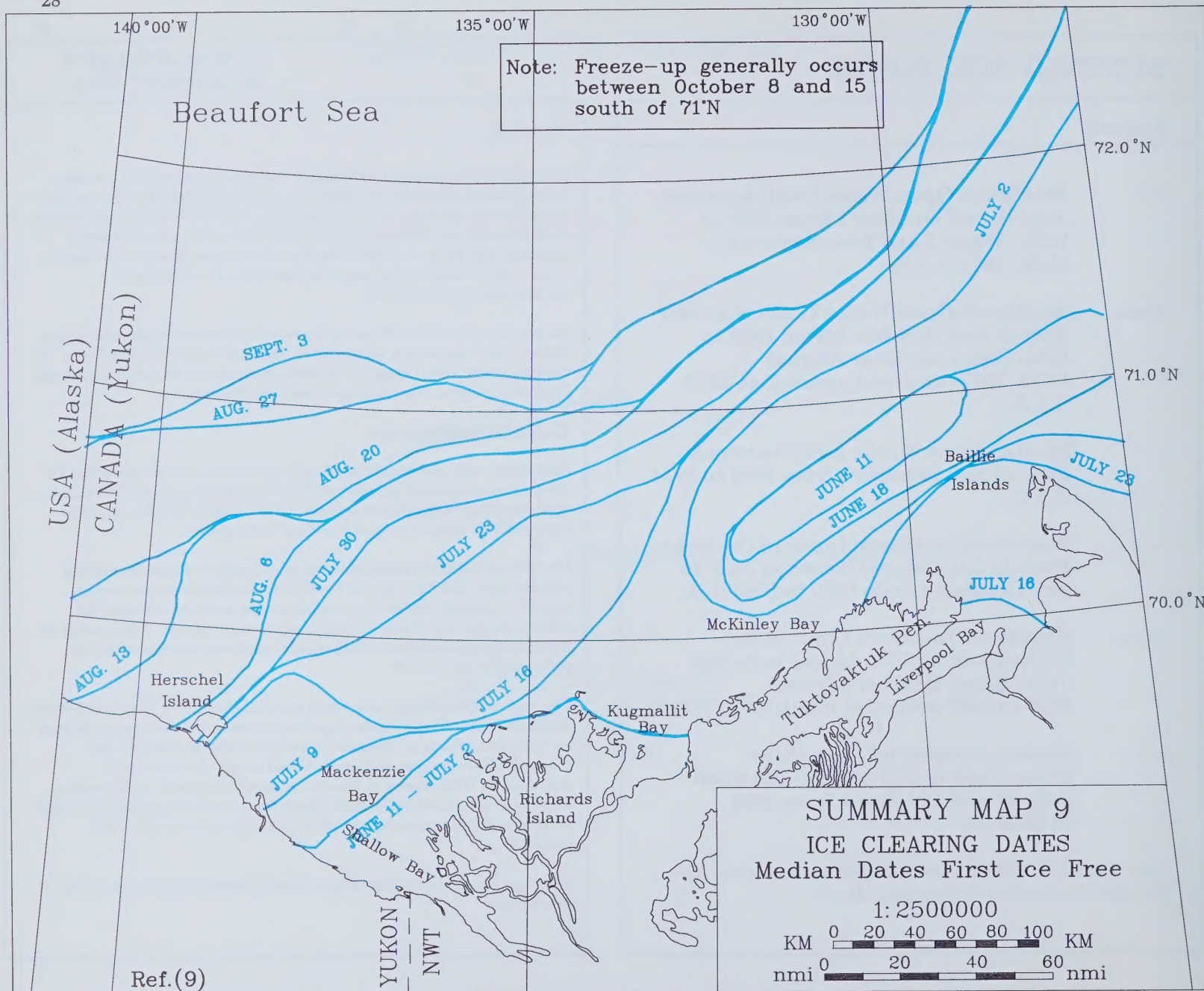
Countermeasures:

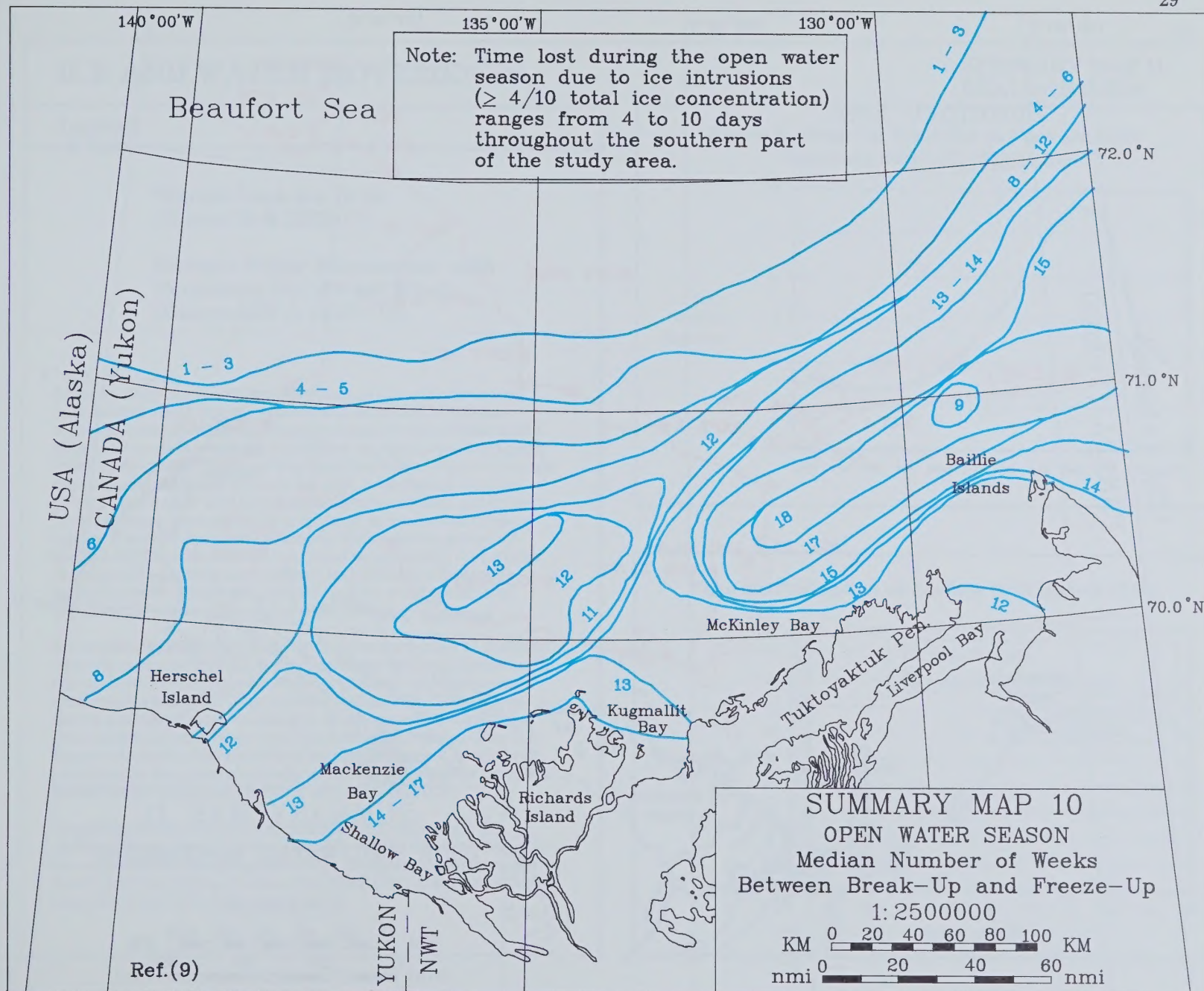
Surveillance and monitoring could be used to determine oil behaviour for the purpose of optimizing cleanup efforts and predicting possible impacts. Aircraft-mounted remote sensing and surveillance overflights could be mounted from base airports at Inuvik or Tuktoyaktuk.

Conventional offshore countermeasures, dispersion or containment for recovery or in-situ burning, are the first options for at- or near-source control. Conditions favourable to offshore countermeasures exist for substantial periods of time during the open water season. Information on marine climatic conditions which could impede containment efforts is contained in Appendix B.

The applicability of dispersant use is generally limited by logistical factors, the availability of appropriate dispersing systems and their applicabilities re: timing and flying conditions. As well, low salinity waters in the Kugmallit Bay area may reduce the effectiveness of conventional dispersants. With respect to the environmental trade-offs of dispersion, dispersant use is justified in the offshore zone, and is also justified in coastal zones when oil threatens waterfowl concentrations or waterfowl habitats.

Shoreline protection countermeasures are discussed in the operational map series.







ICE AND WATER MOVEMENTS

Legend

- Winter Pack Ice Drift
(Buoys 10 & 1273) (7).
- Surface Water Movements with
Persistent Northwest Winds
(Buoys 4521 & 4522) (10).

Satellite buoy tracks are mapped here to show the potential variability in both the magnitude and direction of surface water and ice movements. Buoys released in the winter north of the 100 m shelf break tend to follow an east to west net drift track under the influence of the Beaufort Gyre. Figure 3 shows the seasonal variation in pack ice drift, with the ice slowing down in the winter and speeding up in the summer as the pack becomes more open and able to respond to local wind driving forces. Figure 4 shows the dramatic difference in potential surface drift speeds between summer (open water) and winter (ice covered). During the summer, individual ice floes will typically move at between 3 and 5% of the wind speed in a direction 30° to the right of the wind direction (11).

Summer buoy trajectories shown in Summary Map 11 indicate easterly surface currents in the nearshore area consistent with the surface flow field proposed for persistent and vigorous northwest winds (12). The current regime with these winds shows a surface water movement which turns to parallel the coast about 10 km offshore and then enters Liverpool Bay (13). Buoys released in the absence of strong northwest winds have remained in the general vicinity of the launch area for up to six weeks before eventually moving off to the west (12).

Prediction of the drift of an actual spill will depend on the ability of the response team to quickly deploy tracking buoys in the water and on the presence of ice. Tracking is considered a more practical approach than prediction (10). Information on near shore currents is in Appendix B.

SUMMARY MAP 11 BEAUFORT SEA

Figure 3. Seasonal Variation in Pack Ice Drift
Rams Buoy Data 1975-1978 (14,15)

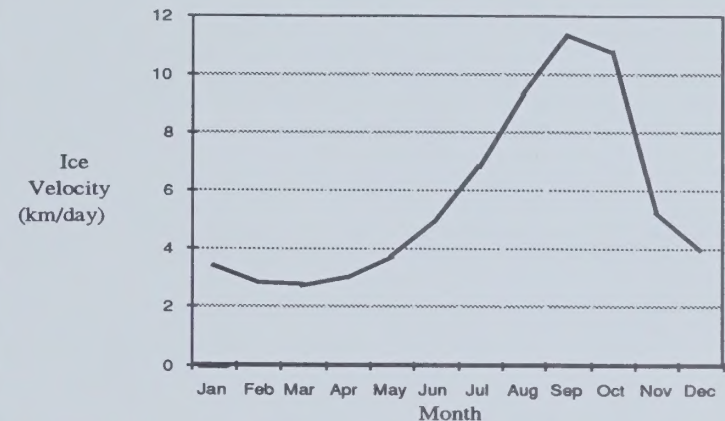
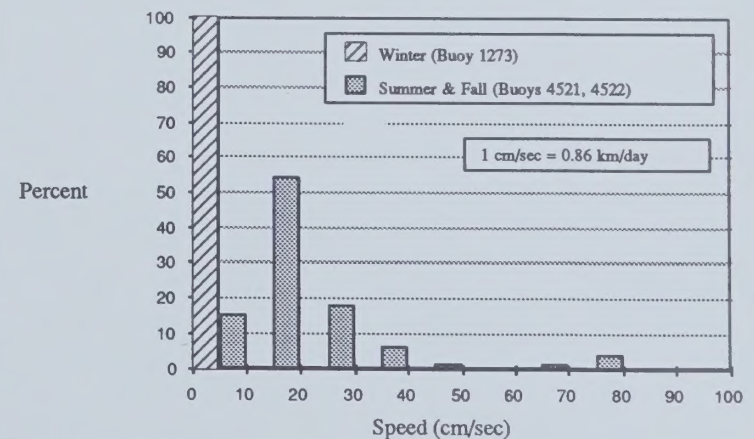
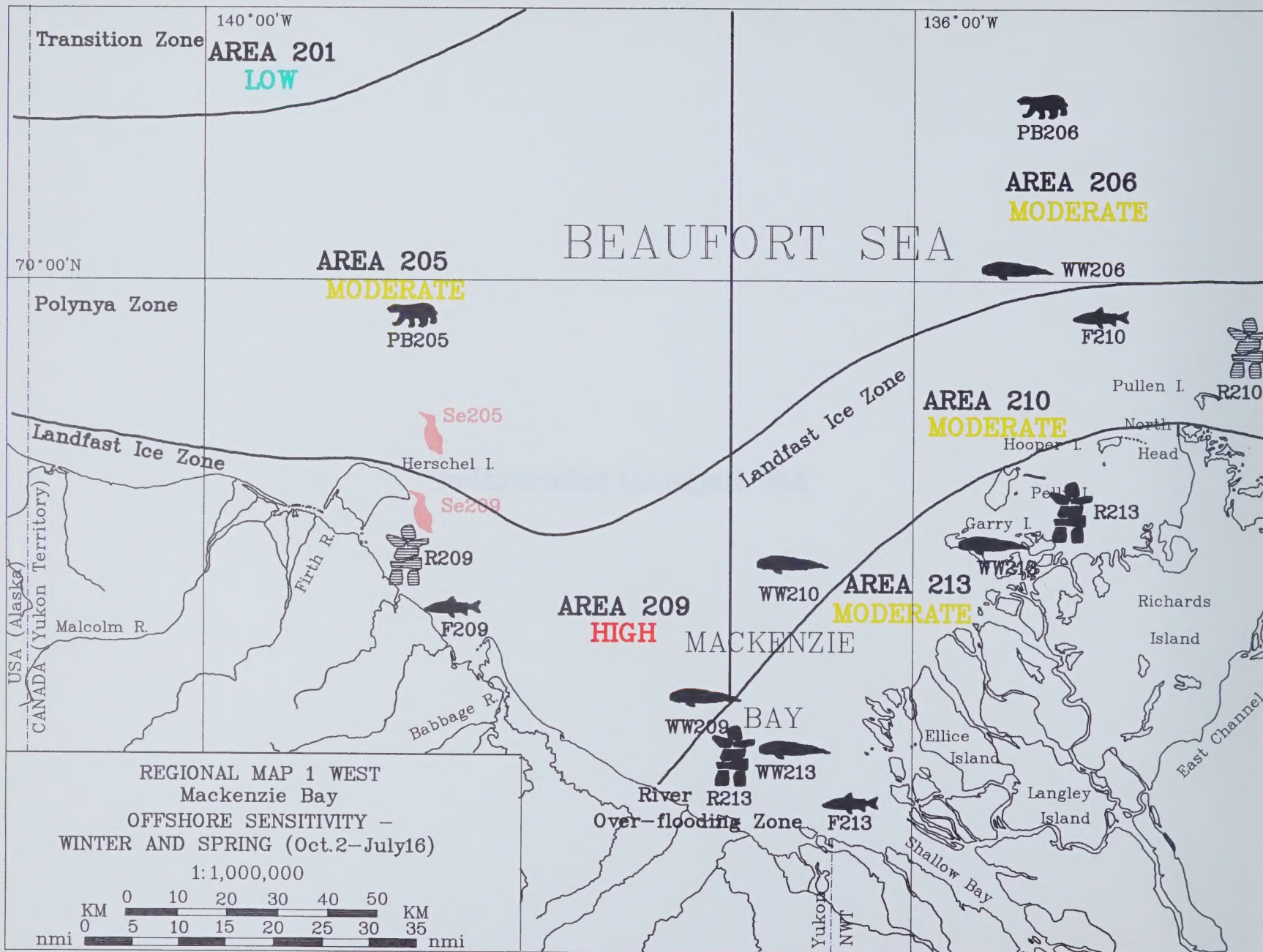
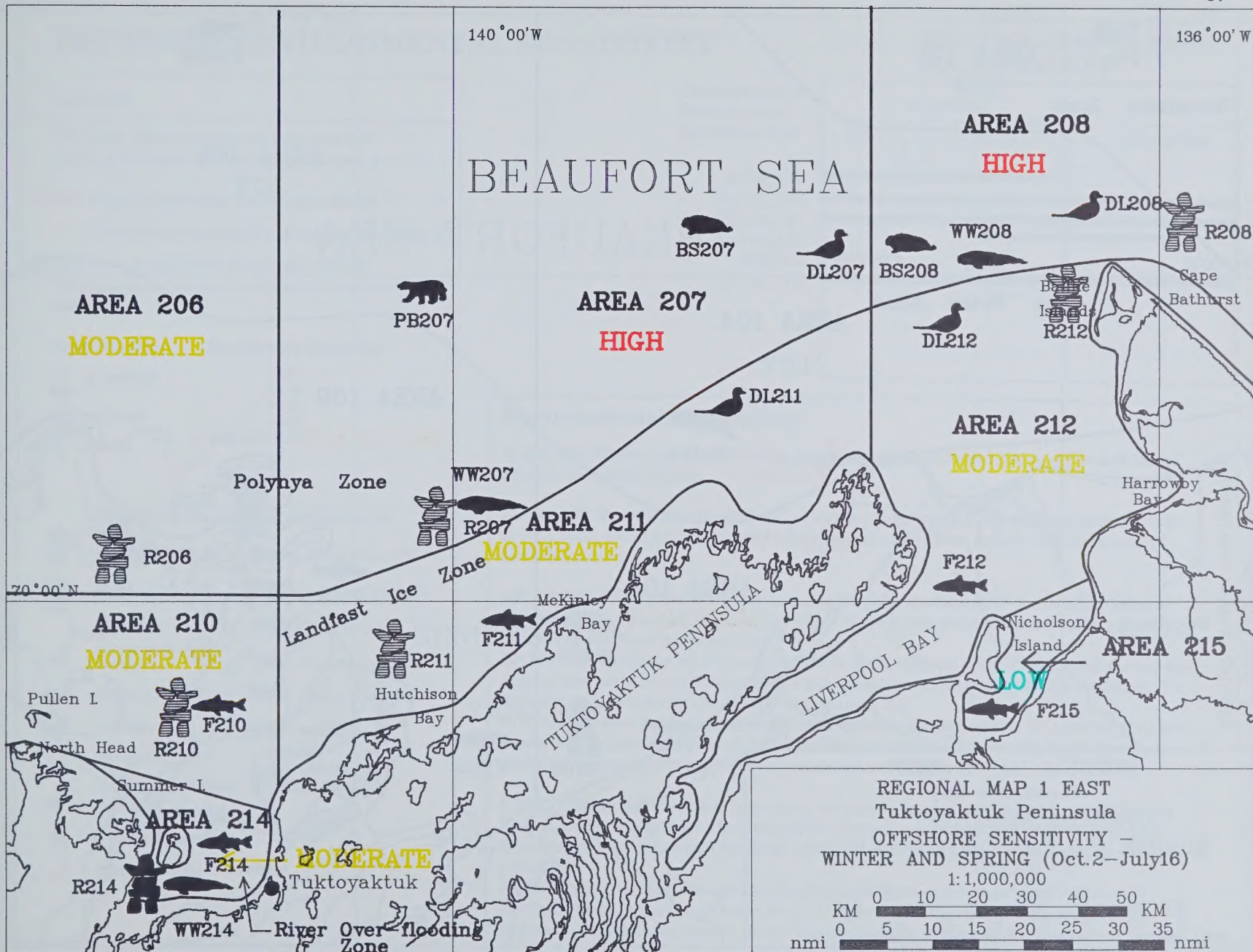


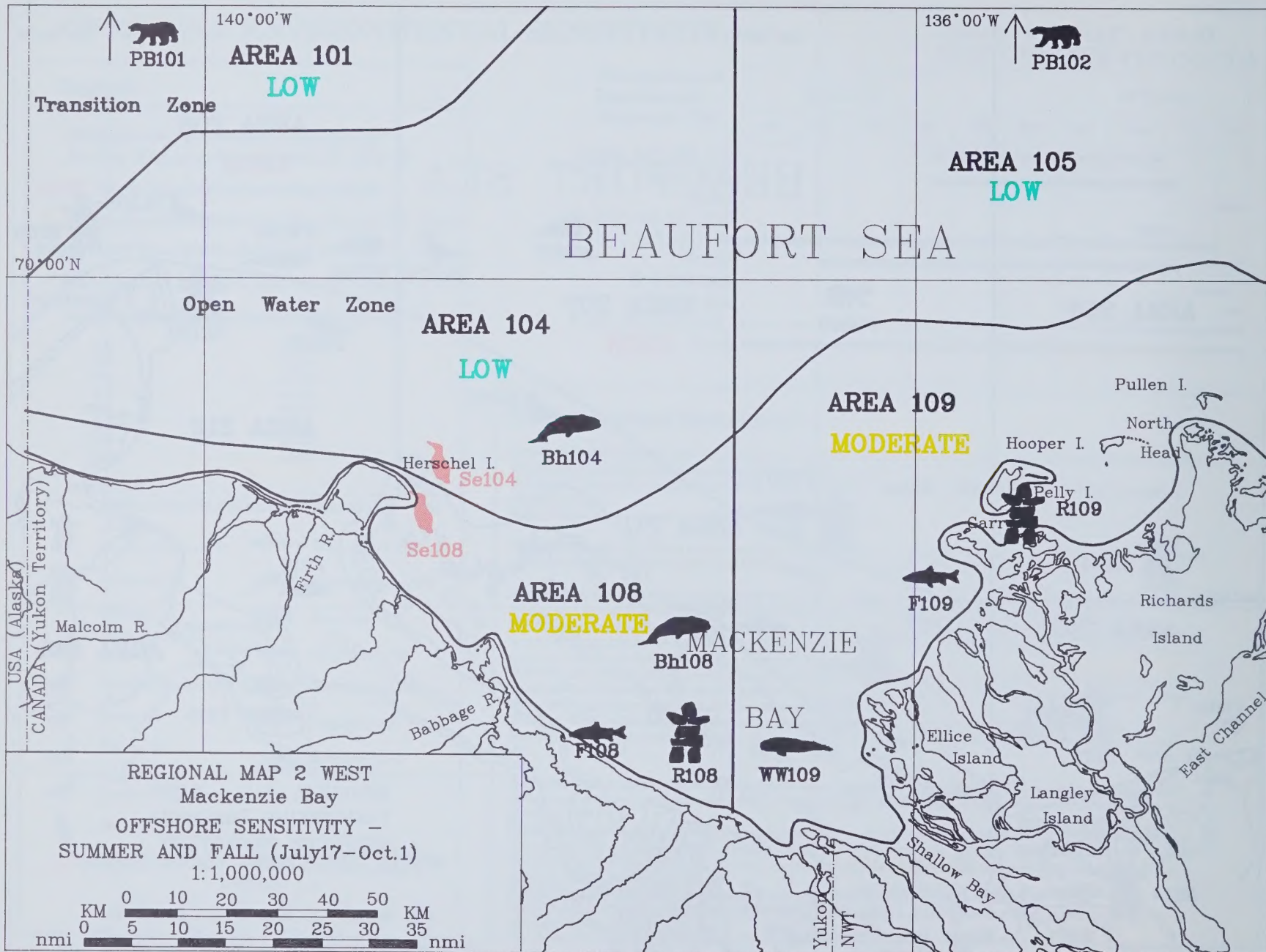
Figure 4. Probability of Surface Drift Speeds (7,10).



3.0 Regional Information







OFFSHORE ENVIRONMENTAL SENSITIVITY

REGIONAL MAP 2 WEST MACKENZIE BAY

Legend

Offshore Environmental Sensitivity*
During Summer & Fall (July 17 - Oct. 1)

-  High Sensitivity Ranking > 68.70
-  Moderate Sensitivity Ranking 35.10- 68.70
-  Low Sensitivity Ranking < 35.10

* See Appendix A. See Operational Maps for Shoreline Sensitivity.

Area Number	Sensitivity Ranking
101	18.25
102	18.25
104	31.25
108	60.00
109	42.50

Resource Harvesting Areas		Mammals
	Highly Important R	 White Whale WW
	Important R	 Bowhead Whale Bh
Birds		 Polar Bear PB
	Diving Ducks & Loons DL	 Ringed Seal RS
	Dabbling Ducks DD	 Bearded Seal BS
	Geese Ge	 Arctic Fox AF
	Swans Sw	 Reindeer Re or Caribou Ca
	Shorebirds & Cranes SC	
	Seabirds Se	Fish
	Site Specific	 Anadromous Fish & Pacific Herring F

Occurrence of Species and Resource Use

R 108, 109
Se 104, 108
PB 101, 102
Bh 104, 108
WW 109
F 108, 109

SUMMER		FALL
July	August	September

Environmental Description:

R 108, 109 Whales are hunted in the Shingle Point, Shoalwater Bay and Kendall Island areas in July and August.

Se 104, 108 From mid July until early October, less than 50 black guillemots breed, rear broods, feed, moult and rest in and adjacent to the nearshore waters east and north of Herschel Island (1, 2).

PB 101, 102 Polar bears concentrate along the polar pack ice edge and hunt for seals in the open water area just south of this edge. As freeze-up proceeds, the numbers of polar bears in these areas increase (30).

Bh 104, 108 Bowhead whales concentrate in areas offshore of the Yukon coast during late August and early September, but their exact location varies from year to year (20, 21, 22). Feeding is the predominant activity in this area (27).

WW 109 White whales concentrate in southeastern Mackenzie Bay for a period of up to 4 weeks during late June/July (4, 6, 7). Feeding activity has occasionally been observed; social behaviour has frequently been observed in this area (5).

F 108 Offshore areas are less important than shoreline habitat for anadromous fish (9). The importance of this area for marine fish species is not known (8). Habitat adjacent to the coastline is important for cisco, whitefish and Arctic char during the open-water period (9).

F109 This is an important summer feeding area for cisco, whitefish and Pacific herring. Areas in the lee of Garry, Pelly, Hooper and Pullen islands are particularly important and are also used by juvenile coregonids for rearing (8, 23, 24).

OFFSHORE ENVIRONMENTAL SENSITIVITY

REGIONAL MAP 2 EAST TUKTOYAKTUK PENINSULA

Legend

Offshore Environmental Sensitivity*
During Summer & Fall (July 17 - Oct. 1)

-  High Sensitivity Ranking > 68.70
-  Moderate Sensitivity Ranking 35.10- 68.70
-  Low Sensitivity Ranking < 35.10

* See Appendix A. See Operational Maps for Shoreline Sensitivity.

Area Number Sensitivity Ranking

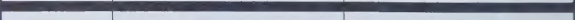
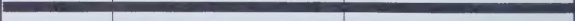
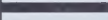
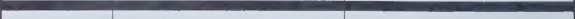
102	18.25
103	18.25
105	1.50
106	38.25
107	13.75
109	42.50
110	22.25
111	10.25

Resource Harvesting Areas

	Highly Important R		Mammals White Whale WW
	Important R		Bowhead Whale Bh
Birds			Polar Bear PB
	Diving Ducks & Loons DL		Ringed Seal RS
	Dabbling Ducks DD		Bearded Seal BS
	Geese Ge		Arctic Fox AF
	Swans Sw		Reindeer Re or Caribou Ca
	Shorebirds & Cranes SC		
	Seabirds Se		
	Site Specific		Fish Anadromous Fish & Pacific Herring F

Occurrence of Species and Resource Use

R 109
R 110
PB 102, 103, 107
Bh 106
BS 106
RS 106
WW 109
F 109, 110, 111

SUMMER		FALL
July	August	September
		
		
		
		
		
		
		
		

Environmental Description:

R 109 Whales are hunted in the Kugmallit Bay area in July and August.

R 110 From September to freeze-up, seals are hunted along Tuktoyaktuk Peninsula and offshore from Toker Point to Warren Point. There is limited whaling off Tuft Point in late August.

PB 102, 103, 107 Polar bears concentrate along the polar pack ice edge and hunt for seals in the open water areas just south of this edge. As freeze-up proceeds, the numbers of polar bears in these areas increase (30).

Bh 106 Bowhead whales concentrate in the area offshore of Tuktoyaktuk Peninsula during late August and early September in most years (25, 26). Feeding is the predominant activity in this area (27). The few whales in the area that have been measured included adults and calves (21).

BS 106 Bearded seals are relatively abundant in the area offshore of Tuktoyaktuk Peninsula during late August and early September (21, 25, 28). Since these animals are also abundant in the area during winter and spring, it is likely that many of these seals are present in the area at times for which there is little available information (i.e., late July to mid August, and mid September to October).

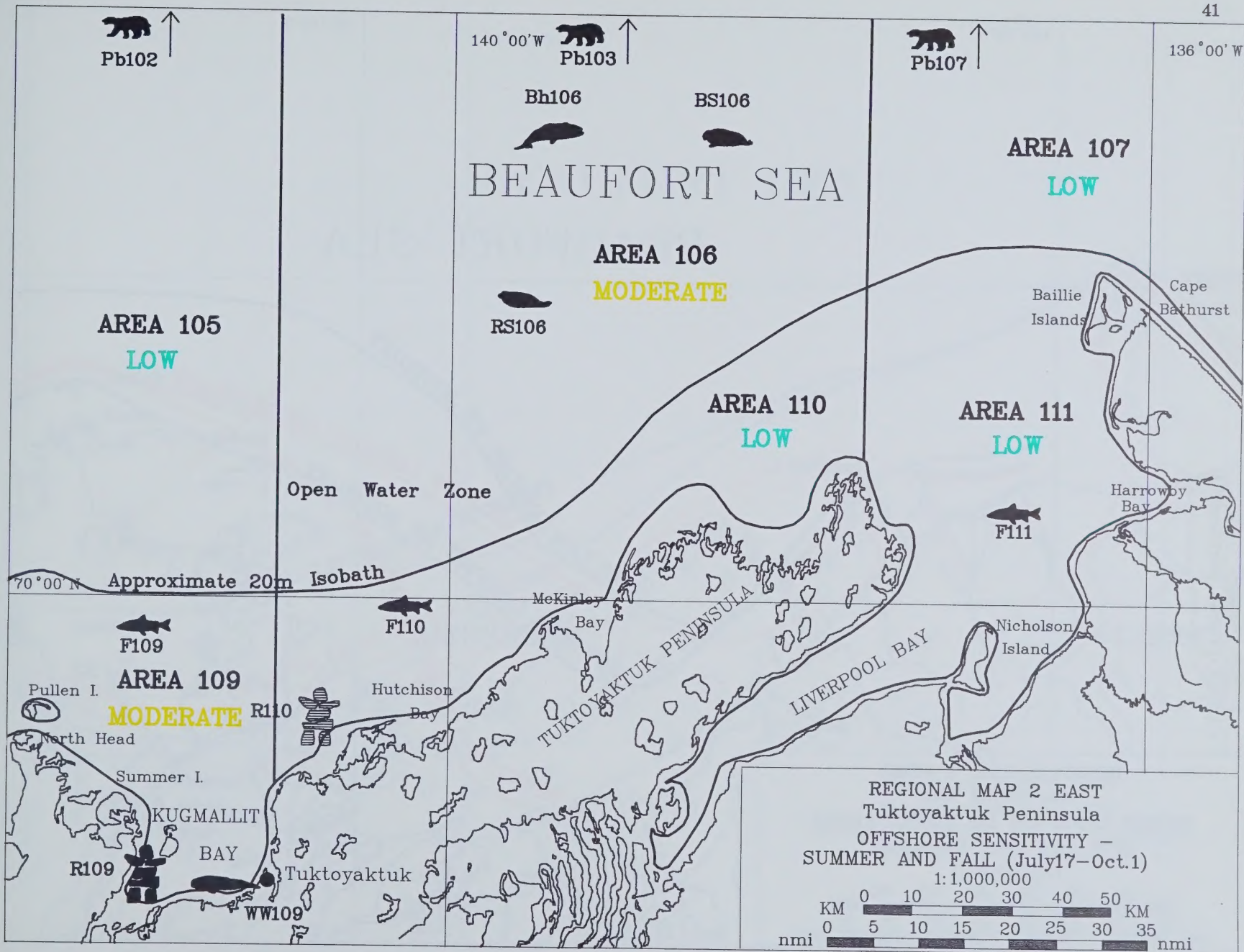
RS 106 Large congregations of ringed seals have been observed offshore of Tuktoyaktuk Peninsula during mid August and September (26, 28, 29). These animals are probably feeding (29).

WW 109 White whales concentrate in Kugmallit Bay for a period of one to three weeks in July (5, 16, 17). Feeding activity has occasionally been observed, and social behaviours have frequently been observed in this area (5).

F 109 This is an important summer feeding area for cisco, whitefish and Pacific herring. The area in the lee of Pullen Island is particularly important and is also used by juvenile coregonids for rearing (8, 23, 24).

F 110 Anadromous fish migrate and feed along the coast during summer (19). Pacific herring are probably also present throughout the area at this time (8). Arctic and least cisco may use offshore areas during the summer (8).

F 111 The fish species and their distribution in this area have not been extensively studied. The Anderson and Kugaluk rivers support large populations of cisco and whitefish, and Eskimo Lakes provide important spawning habitat for Pacific herring (8, 18). All these fish species may use portions of this area during the summer for feeding or rearing.

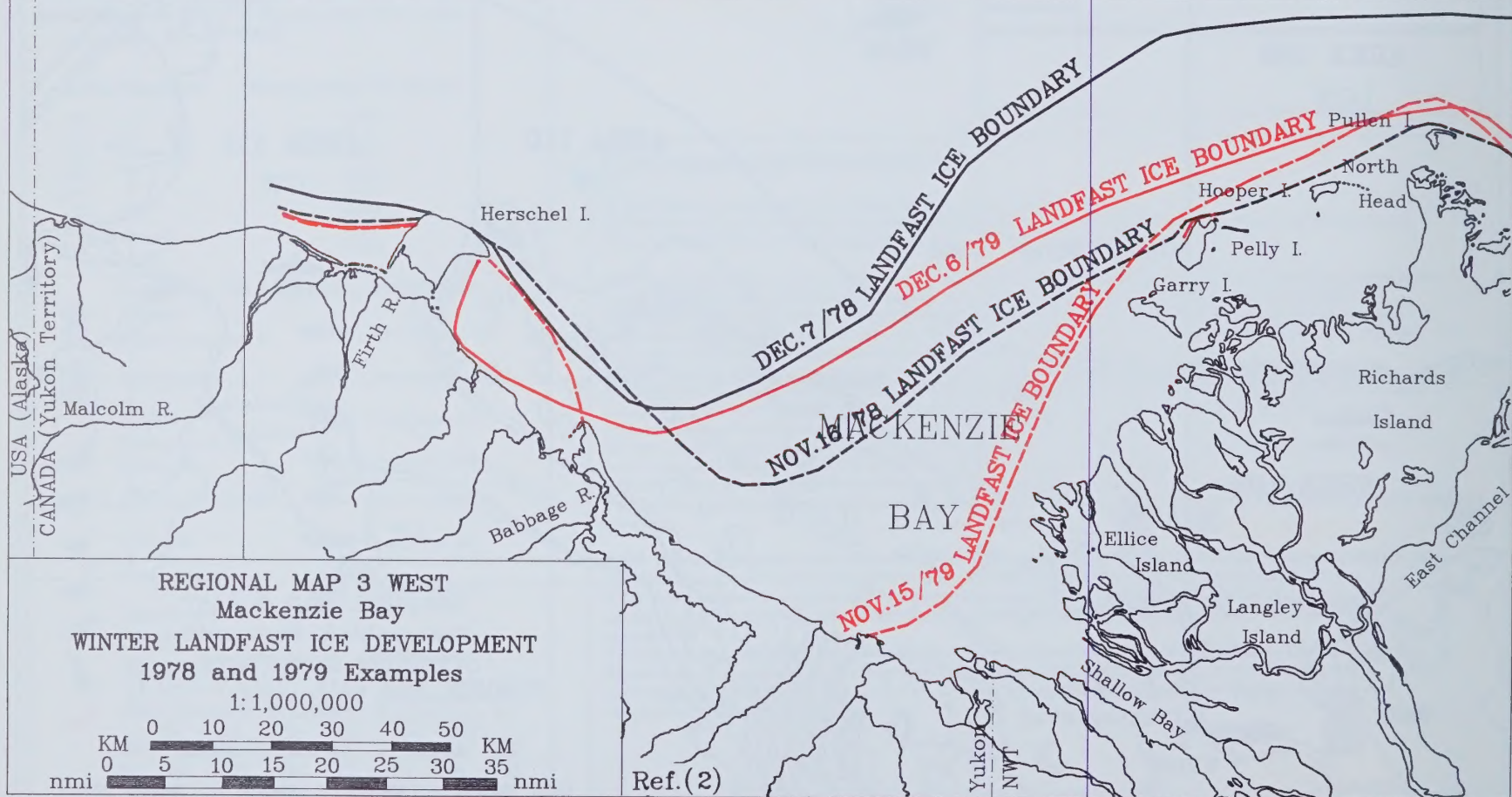


140°00'W

136°00'W

70°00'N

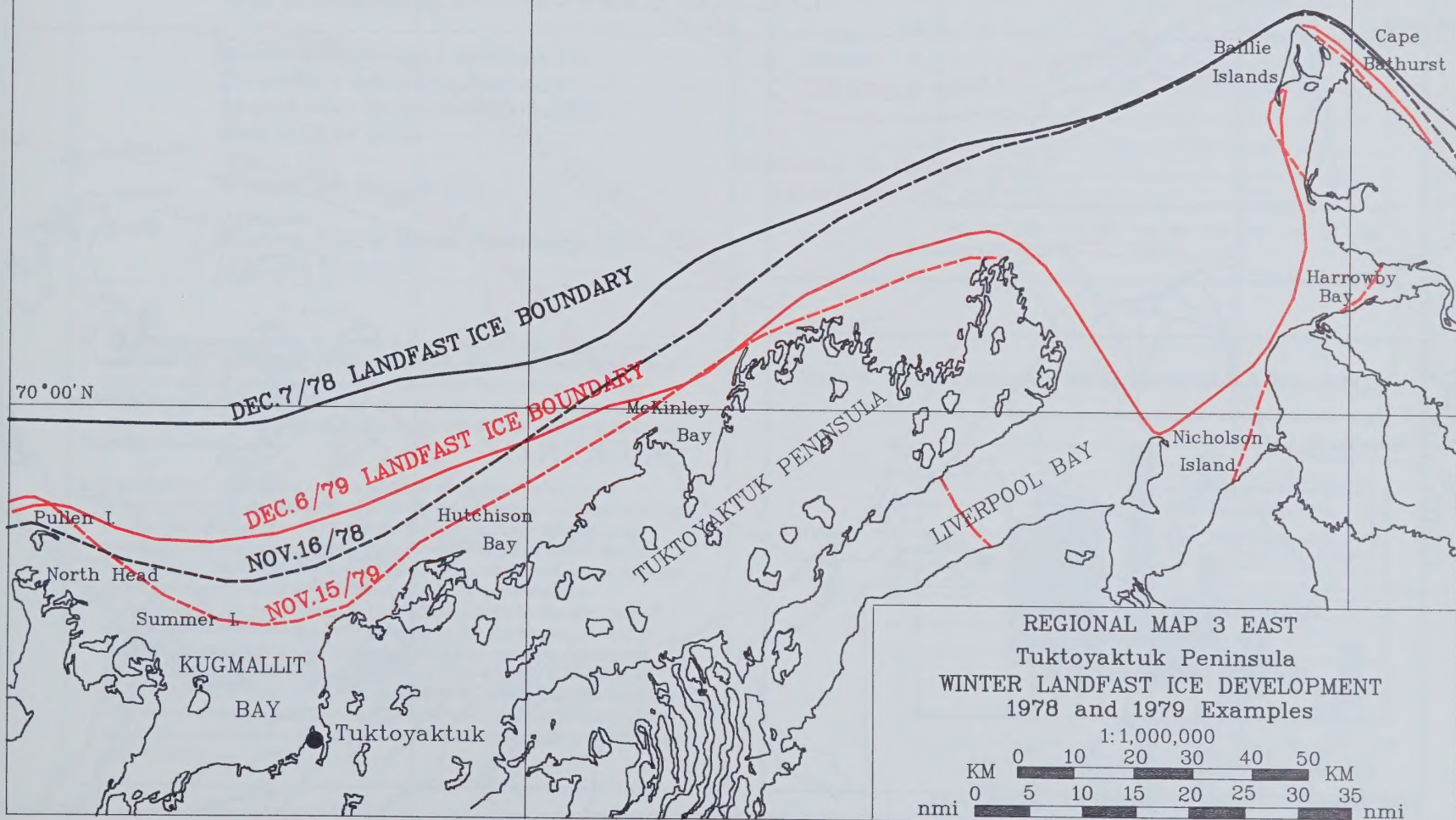
BEAUFORT SEA



140°00'W

136°00'W

BEAUFORT SEA



REGIONAL MAP 3 EAST

Tuktoyaktuk Peninsula

WINTER LANDFAST ICE DEVELOPMENT
1978 and 1979 Examples

1:1,000,000

KM 0 10 20 30 40 50 KM

nmi 0 5 10 15 20 25 30 35 nmi

140°00'W

136°00'W

Transition Zone (Moving Ice)

70°00'N

BEAUFORT SEA

MAXIMUM SEAWARD LANDFAST ICE LIMIT

Region of Landfast
Ice Instability

MEDIAN SEAWARD LANDFAST ICE BOUNDARY

MINIMUM SEAWARD LANDFAST ICE LIMIT

Herschel I.

Pullen I.

North
Head

Hooper I.

Pelly I.

Garry I.

Richards
Island

MACKENZIE

BAY

Always Landfast Ice

Babbage R.

Firth R.

Malcolm R.

REGIONAL MAP 4 WEST
Mackenzie Bay
WINTER LANDFAST ICE

1:1,000,000

KM 0 10 20 30 40 50 KM
0 5 10 15 20 25 30 35 nmi

USA (Alaska)
CANADA (Yukon Territory)Yukon
NWT

East Channel

Shallow Bay

Langley
IslandEllice
Island

WINTER LANDFAST ICE

Legend



Range in Seaward Landfast Ice Boundaries observed between January 14 and May 31 from 1970 to 1971 and 1973 to 1983 (1,2,3).



Median Seaward Landfast Ice Boundary between January 14 and May 31 from 1970 to 1971 and 1973 to 1983.



Winter Ice Roads (16).



Survey Flight lines, February 1974 (17), See Figure 6.

Notes:

1. Ice growth curves shown in Figure 5 are based on long term records available for Cape Parry. Although outside the atlas study area, Cape Parry is used in preference to other Beaufort Sea coastal locations because of the consistency of the ice thickness records. Annual freezing degree day accumulations at Cape Parry are almost identical to stations within the study area.
2. Landfast ice limits in any given year are strongly related to the presence of grounded ice features which act to anchor the fast ice along its seaward extremities. The numbers of ice features available to ground on the seabed fall off sharply beyond the 20 m water depth. Landfast ice in Mackenzie Bay bridges across water well beyond water depths where ice stability can be enhanced by grounded ice. Consequently, ice in this area is highly vulnerable to the pressure of offshore pack ice and wind forces during major storm events. Large displacements of fast ice in Mackenzie Bay are common during the winter, leading to the cautionary note on Map 4 West, REGION OF LANDFAST ICE INSTABILITY. Landfast ice along the Tuktoyaktuk Peninsula, although variable from year to year, retains a remarkably stable edge position during any given winter from January to May (see Map 4 East).

REGIONAL MAP 4 WEST MACKENZIE BAY

Figure 5. Landfast Ice Growth (18)

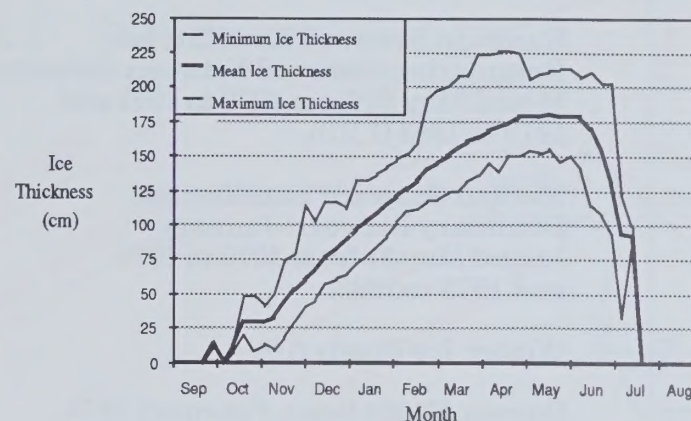
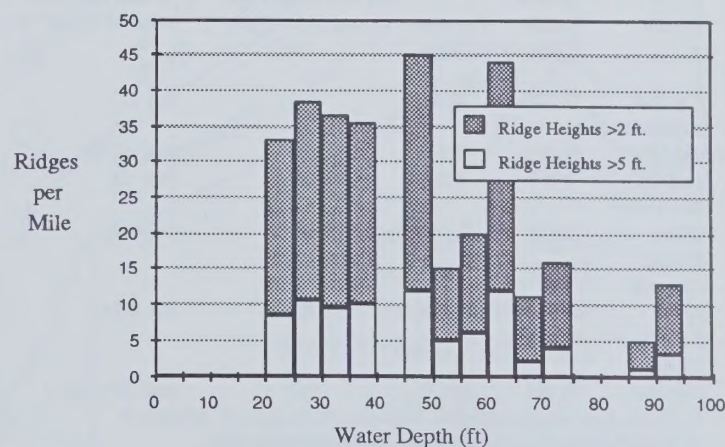


Figure 6. Ridge Frequency off Richards Island, Feb. 1974 (17).



WINTER LANDFAST ICE

Legend



Range in Seaward Landfast Ice Boundaries observed between January 14 and May 31 from 1970 to 1971 and 1973 to 1983 (1,2,3).



Median Seaward Landfast Ice Boundary between January 14 and May 31 from 1970 to 1971 and 1973 to 1983.



Winter Ice Roads (16).



Survey Flight lines, February 1974 (17), see Figure 8.

Table 1.
Recommended Safe Ice Thickness for Over Ice Traffic

Vehicle	Gross Vehicle Weight (kg)	Payload (kg)	Ice Thickness for a Moving Load During Mid-Winter*1 (cm)	Average Earliest Date Allowed on Ice *2
Cat D-8 Kenworth 953A	32,205	N/A	96	Jan 1-7
Bell 212	54,885	27,215	153	Mar 12-18
DH Twin Otter	4,990	2,265	45	Nov 18
Boeing Chinook 234	5,670	2,041	47	Nov 18
Lockheed C130H	23,133	12,700	101	Jan 8-14
Hercules	70,307	23,133	163	Mar 26 - Apr 1

*1 For surface ice temperatures between -10 C and -5 C (Figure 7)

*2 From Landfast Ice Growth for Cape Parry (Figure 5)

REGIONAL MAP 4 EAST TUKTOYAKTUK PENINSULA

Figure 7. Ice Bearing Capacity (19,20)

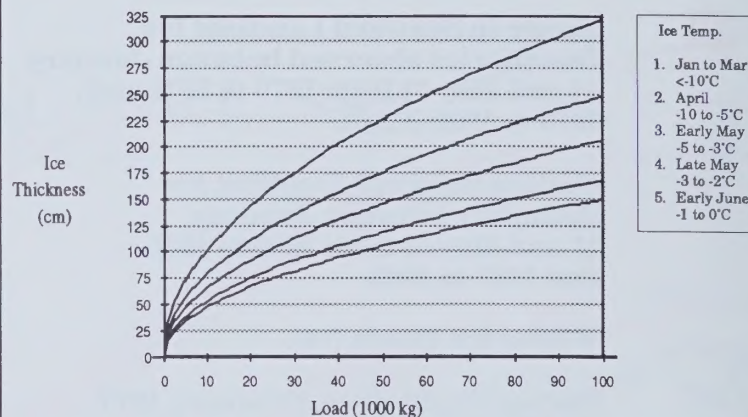
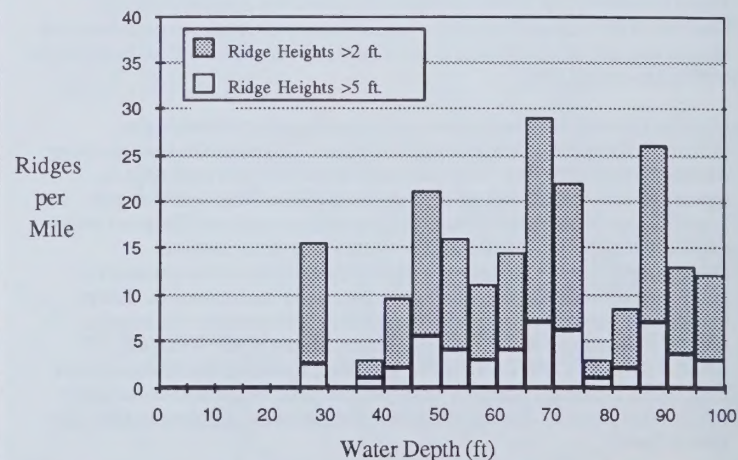


Figure 8. Ridge Frequency off McKinley Bay, Feb. 1974 (17)

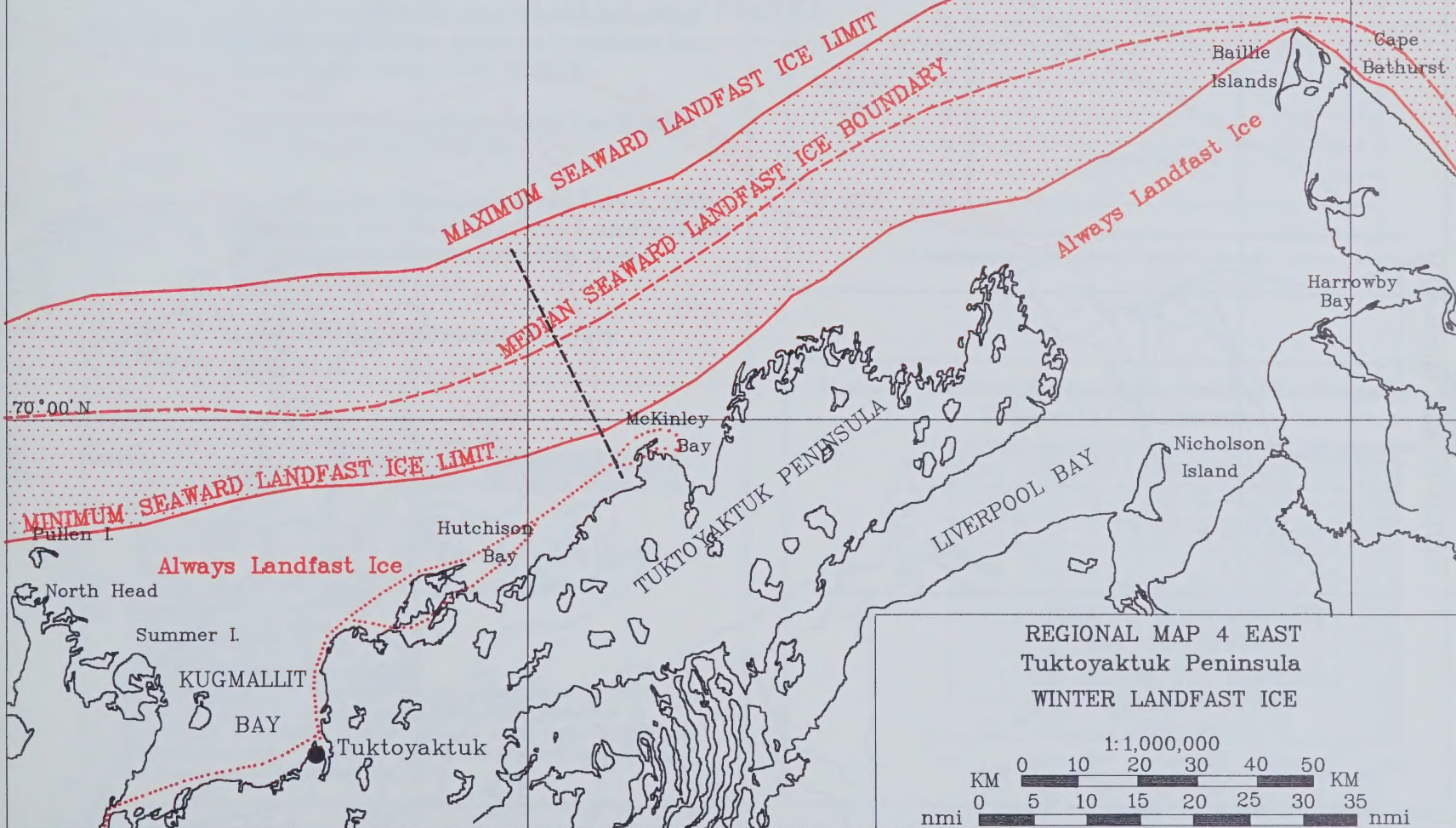


140°00'W

136°00'W

Transition Zone
(Moving Ice)

BEAUFORT SEA



140°00'W

136°00'W

Pack Ice June 18

BEAUFORT SEA

70°00'N

Polynya June 18

LANDFAST ICE EDGE JUNE 13-15

JULY 4

JULY 4
Ice

JULY 11

Pullen I.

North

Head

Hooper I.

Pelly I.

Garry I.

Richards

Island

East Channel

MACKENZIE

BAY
Open waterEllice
IslandLangley
Island

Shallow Bay

Yukon
NWT

Babbage R.

Firth R.

Malcolm R.

REGIONAL MAP 5 WEST

Mackenzie Bay

LANDFAST ICE BREAK-UP
1976 Example

1:1,000,000

KM 0 10 20 30 40 50 KM
0 5 10 15 20 25 30 35 nmi

USA (Alaska)
CANADA (Yukon Territory)

LANDFAST ICE BREAK-UP - 1976 EXAMPLE

REGIONAL MAP 5 WEST MACKENZIE BAY

Legend



Polynya (open water area), June 18, 1976 (1).



Open Water Following Flooding of the Mackenzie River prior to Landfast Ice Break-up, June 13-15, 1976 (2).



Landfast Ice Limit prior to Ice Break-up, June 13-15, 1976 (2).



Landfast Ice Remaining on July 4, 1976 following Fracturing of the Landfast Ice Sheet across Mackenzie Bay and Kugmallit Bay (21).

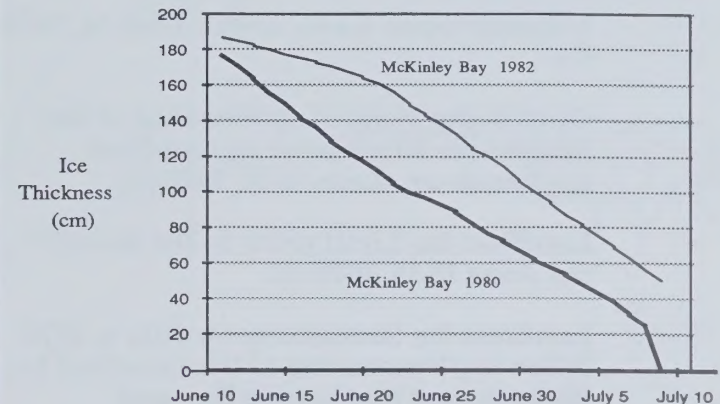


Landfast Ice Remnants on July 11, 1976 (21).

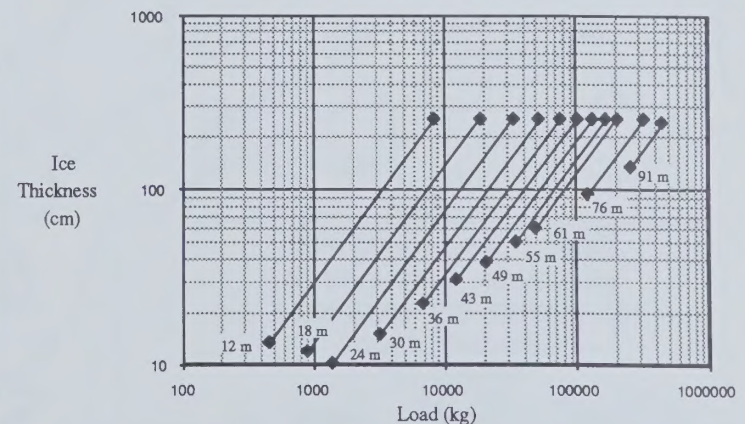
Notes:

- Cracked Ice Bearing Capacity, Figure 10
Use this chart for aircraft landing only if weight is less than that predicted from Figure 7 modified with regard to crack type as follows (23):
- non-intersecting wet cracks Wt. x 0.5
- intersecting wet cracks Wt. x 0.25.
- General Modifiers to Spring Ice Bearing Capacity
For rapid temperature drops:
- 5° C/day use Wt. x 0.5
- 10° C/day use Wt. x 0.25
- >10° C/day suspend operations.
For operations with average daily temperatures > -1.8° C use Curve 5 (Figure 7) until surface deterioration prevents operations. Expect maximum one week to ten days further use after surface water drains. Suspend operations when average daily temperature exceeds 5° C (23).

Figure 9. Examples of Landfast Ice Ablation (22)



**Figure 10. Ice Bearing Capacity for Cracked Ice Sheets (23)
For Given Ice Crack Spacings**



LANDFAST ICE BREAK-UP – 1976 EXAMPLE

REGIONAL MAP 5 EAST TUKTOYAKTUK PENINSULA

Legend



Polynya (open water area), June 18, 1976 (1).



Open Water Following Flooding of the Mackenzie River prior to Landfast Ice Break-up, June 13-15, 1976 (2).



Landfast Ice Limit prior to Ice Break-up, June 13-15, 1976 (2).



Landfast Ice Remaining on July 4, 1976 following Fracturing of the Landfast Ice Sheet across Mackenzie Bay and Kugmallit Bay (21).



Landfast Ice Remnants on July 11, 1976 (21).

Table 2.
Dates of Ice Break-Up Events for the
Mackenzie Bay and Tuktoyaktuk Landfast Ice (1973-1983)

Event	Earliest Date	Latest Date	Median Date
Large ice floes break off ice edge	June 5	June 29	June 16
Mackenzie ice barrier breaks	June 12	July 7	June 24
Kugmallit ice barrier breaks	June 19	July 18	June 30
All fast ice broken	July 1	August 5	July 16

(24)

Figure 11 (page 53) shows a Landsat satellite mosaic of ice break-up along the Beaufort Sea coast during the period June 22-29, 1980. The influence of river flooding and containment of sediment laden fresh water behind the remaining landfast ice barrier off the Mackenzie Delta are clearly visible.

BEAUFORT SEA

Polynya June 18

Baillie
Islands

Cape
Bathurst

Harrowby
Bay

Nicholson
Island

70° 00' N

JULY 4

Pullen · 1

JULY 11

North Head

Summer I.

KUGMALLIT

BAY

Tuktoyaktuk

LAND
JULY 11

Hutchinson Bay

McKinley Bay

A map of the Tuktuyaktuk Peninsula. The word "Ice" is written in red above a line representing a river or ice flow. Below it, "McKinley Bay" is labeled. The peninsula itself is outlined in black, and the surrounding water is white. The text "TUKTUYAKTUK PENINSULA" is written in black capital letters across the bottom of the map.

LIVERPOOL BAY

REGIONAL MAP 5 EAST
Tuktoyaktuk Peninsula
LANDFAST ICE BREAK-UP
1976 Example

1:1,000,000

0 10 20 30 40 50 KM

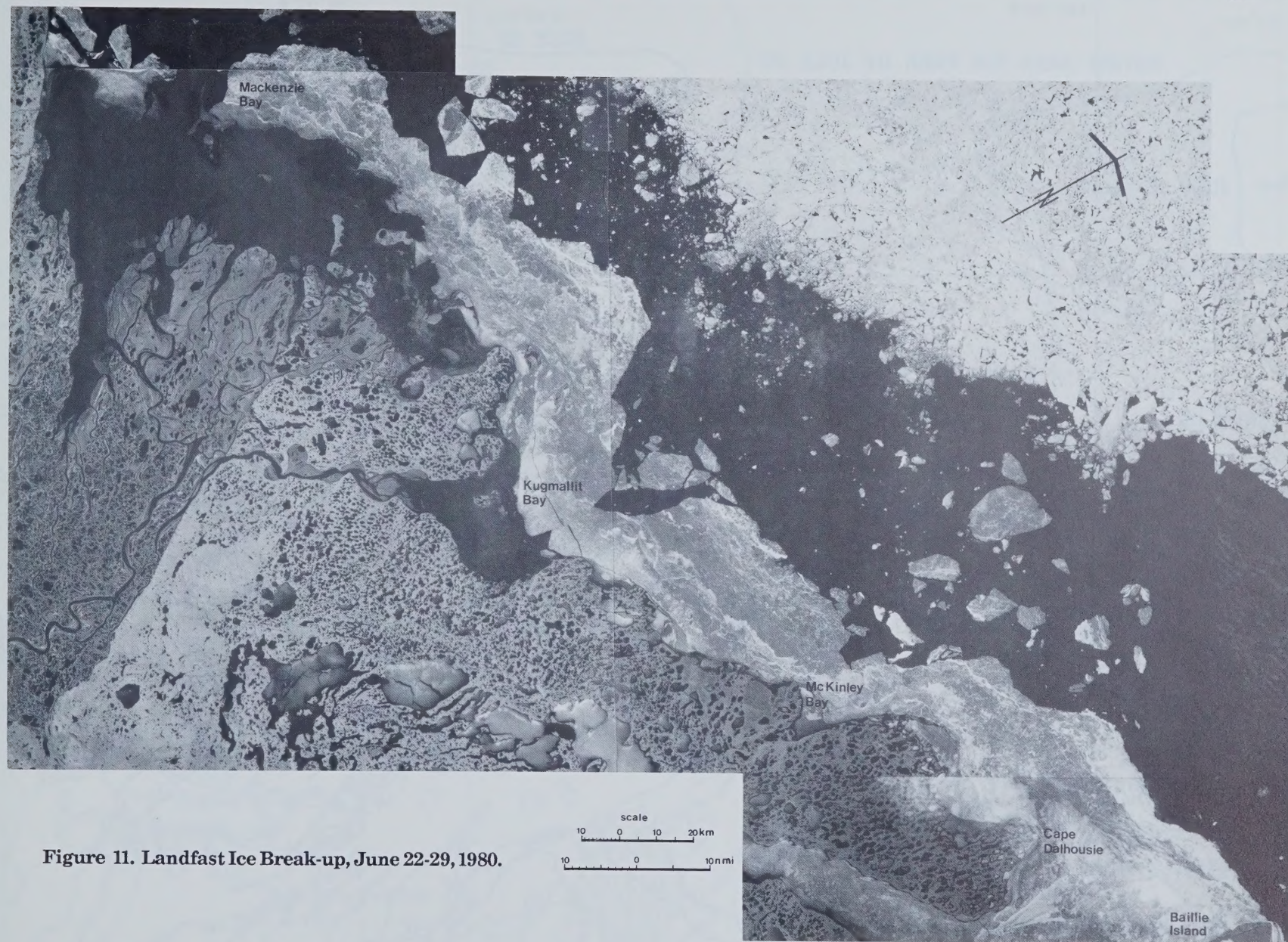
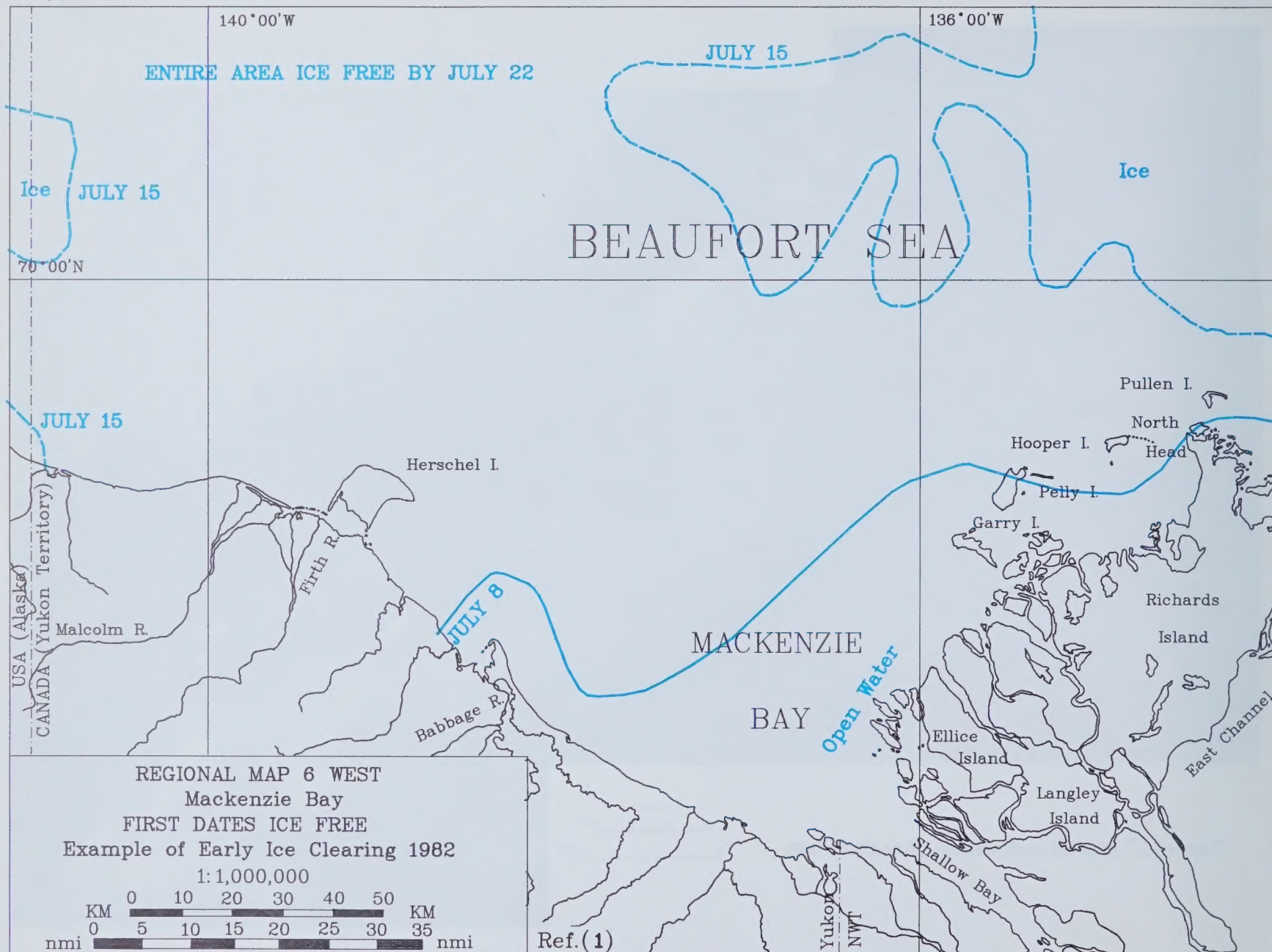
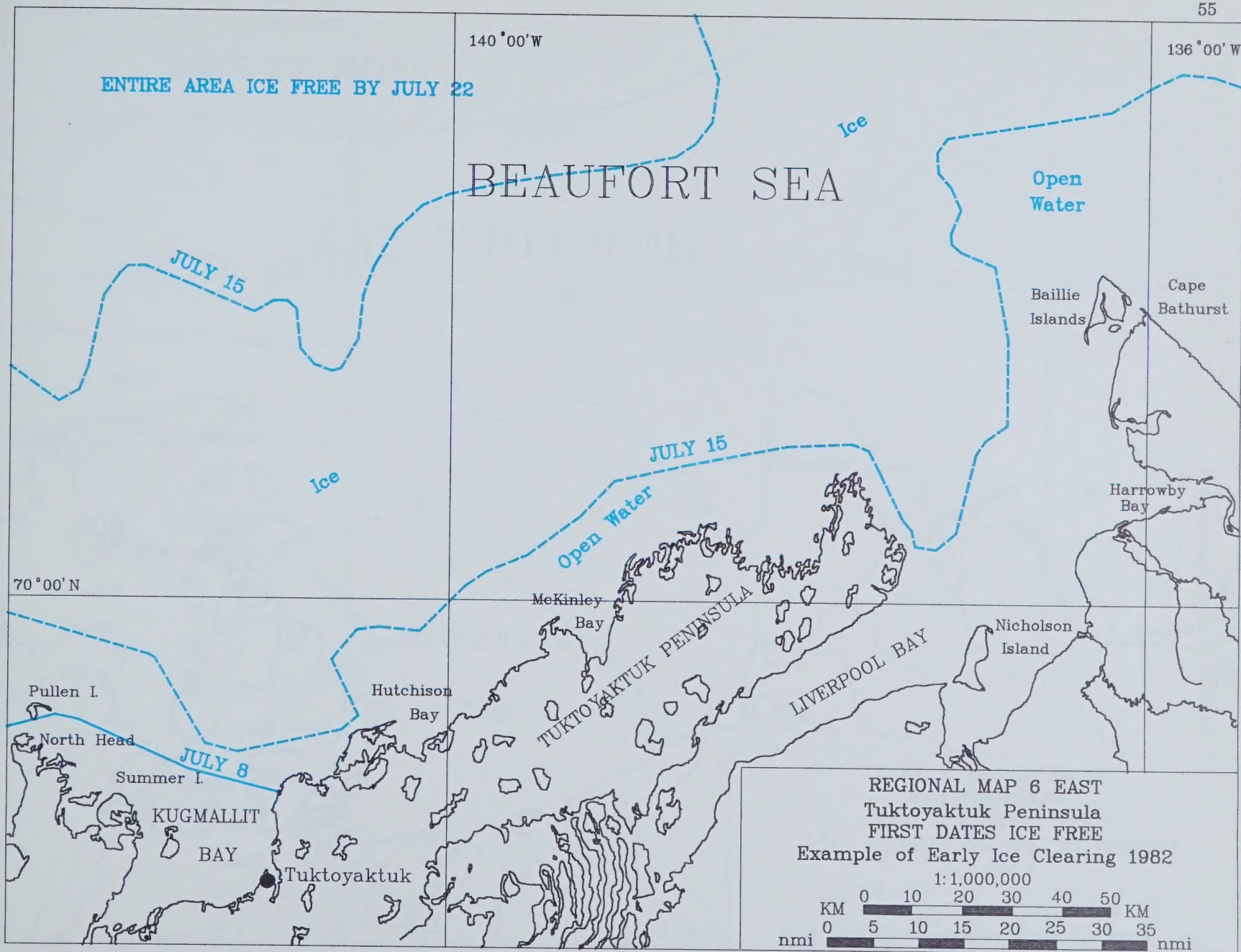
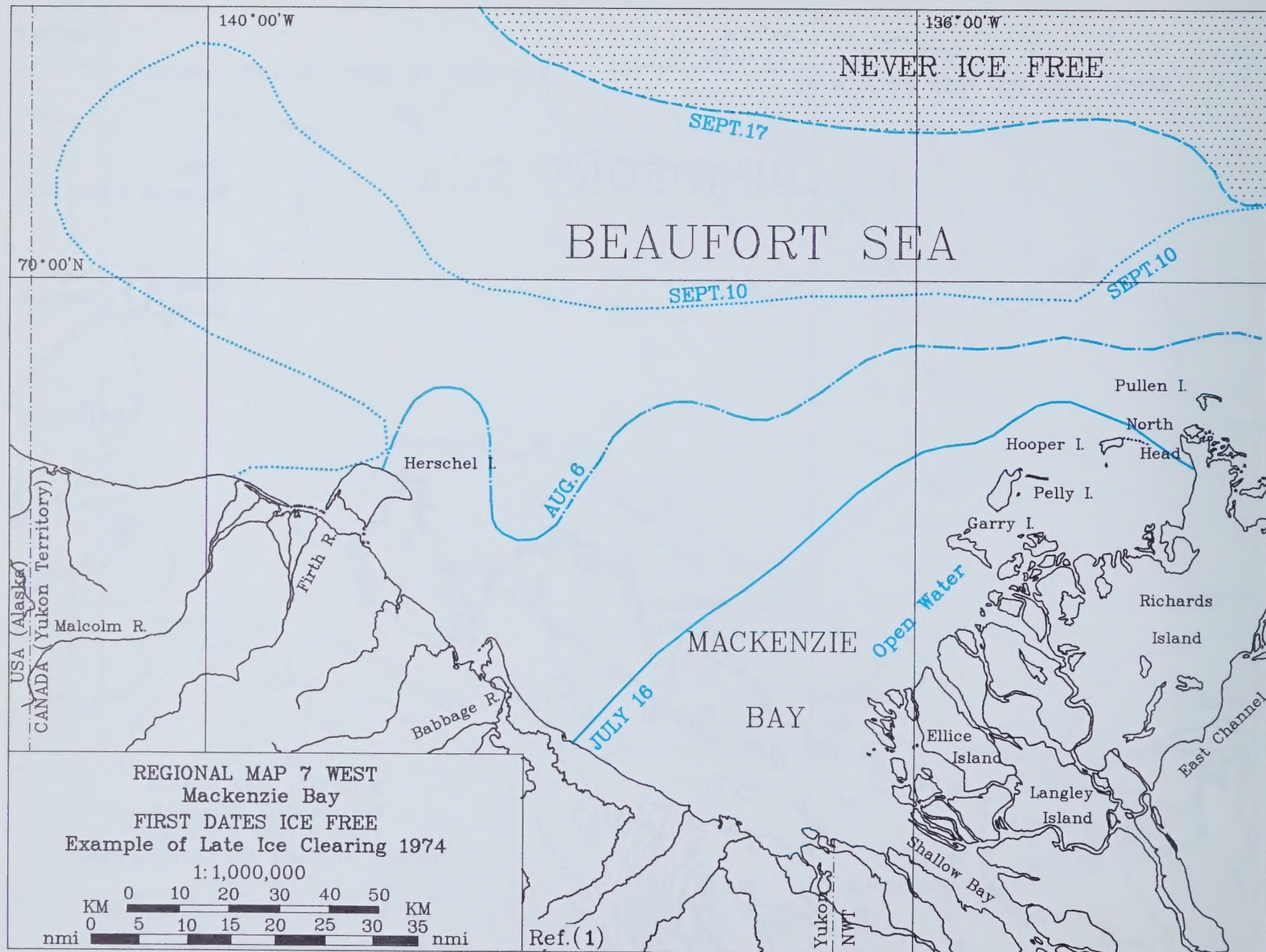
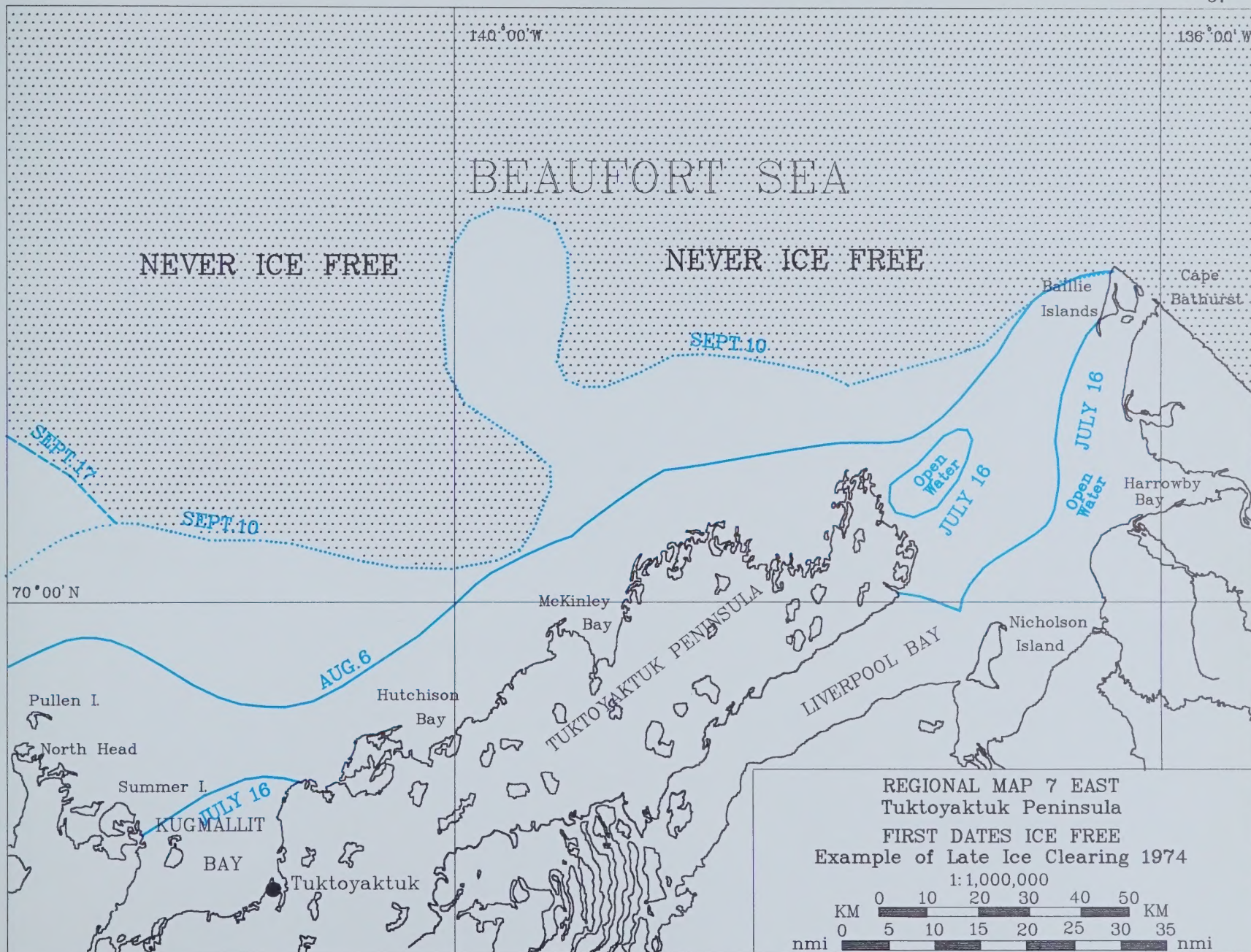


Figure 11. Landfast Ice Break-up, June 22-29, 1980.





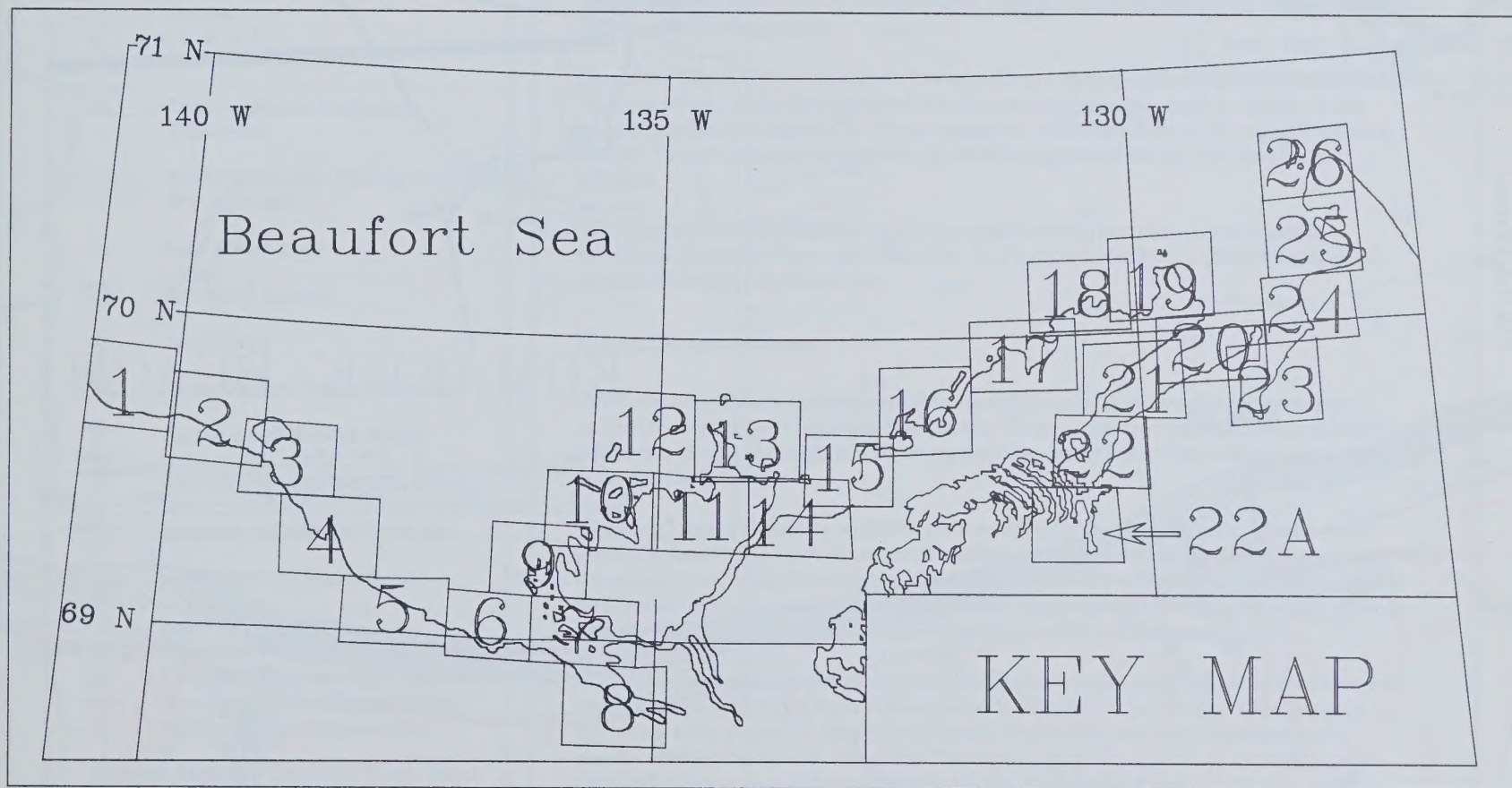




4.0 Operational Information

Physical Environment & Logistics

Shoreline Environmental Sensitivities



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 1 KOMAKUK BEACH

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Komakuk Beach, Map 1

Hydrographic Chart - 7661

Video Tapes - AGC 10, Dome 1, 2

Access:

The 3-metre contour line parallels the coast at a distance of 540 m offshore. Access into Clarence Lagoon is restricted to vessels drawing less than 1.8 m. Entry into this channel may be restricted because of recent coastal sediment deposition. Inside Clarence Lagoon depths vary little from 2.4 m. Steep offshore gradients facilitate barge access onto the ocean side of Clarence spit. Clarence Lagoon offers good landing access and shelter for floatplanes.

Komakuk Beach DEW line station has a 1,060 m long gravel airstrip that is suitable for year-round use, and a landing beach for dry-ramping landing craft or shallow draft barges (gradient of about 1:7). Winter airstrips have been built on the ice at Komakuk Beach. Unprotected anchorage with good holding ground can be obtained 1 km offshore.

The nearest alternative anchorage for vessels drawing less than 1.5 m is inside Workboat Passage, 60 km east (Map 2 or 3). Pauline Cove (Map 3), 90 km east, offers good anchorage in depths to 5 m.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

Clarence Lagoon should be sealed to prevent oiling of the inshore area. Currents are generally less than 1 knot; however, if onshore winds are strong, deflector booms may be required at the lagoon entrance. Slicks that approach other areas of the coast should be diverted to the less sensitive cliff shorelines that predominate this map area. Pumps and skimmers can be used to collect oil that is diverted in this manner.

Cliff shorelines and exposed gravel beaches that are not heavily contaminated may not require active cleaning efforts. Three potential disposal sites are identified, each in the vicinity of a cleanable (i.e., gravel) beach. Due to the possible disturbance of a nearby archaeological site, use of the Clarence Lagoon site should be avoided. Stockpiled material could be transferred to the Backhouse River site via ice road in winter.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 1 KOMAKUK BEACH

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

1	Clarence Lagoon	43.50
2	Backhouse River	31.50
3	Komakuk Beach	33.95

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting

Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

Reindeer Re or Caribou Ca

Fish

Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

Oil Exposed on Shoreline												
May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	

Environmental Description:

R 1, 2, 3 Although this area is not currently being used for resource harvesting, it is an area of cultural importance. There are several archaeological sites along the coast. In addition, this area lies within the Northern Yukon National Park.

Ca 1 During late June and early July, a significant portion of the Porcupine caribou herd (cows and calves) uses marshy areas from the U.S.-Canada border to Clarence Lagoon (24).

F 1 Protected coastal embayments such as Clarence Lagoon are important summer feeding areas for marine and anadromous fish species (1).

F 2 Coastal areas, particularly within a few hundred meters of the coast, are important summer feeding areas and migration corridors (1, 2).

F 3 Fish Creek supports a population of approximately 1000 Arctic char. Upstream spawning migrations begin in mid September, and seaward migrations of adults and smolts occur during breakup (May to June) (1).

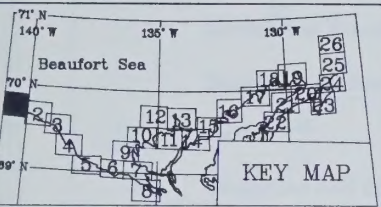
OPERATIONAL MAP 1 Komakuk Beach SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

0 1 2 3 4 5
KM

Mercator Projection

0 1 2 3 4
nmi

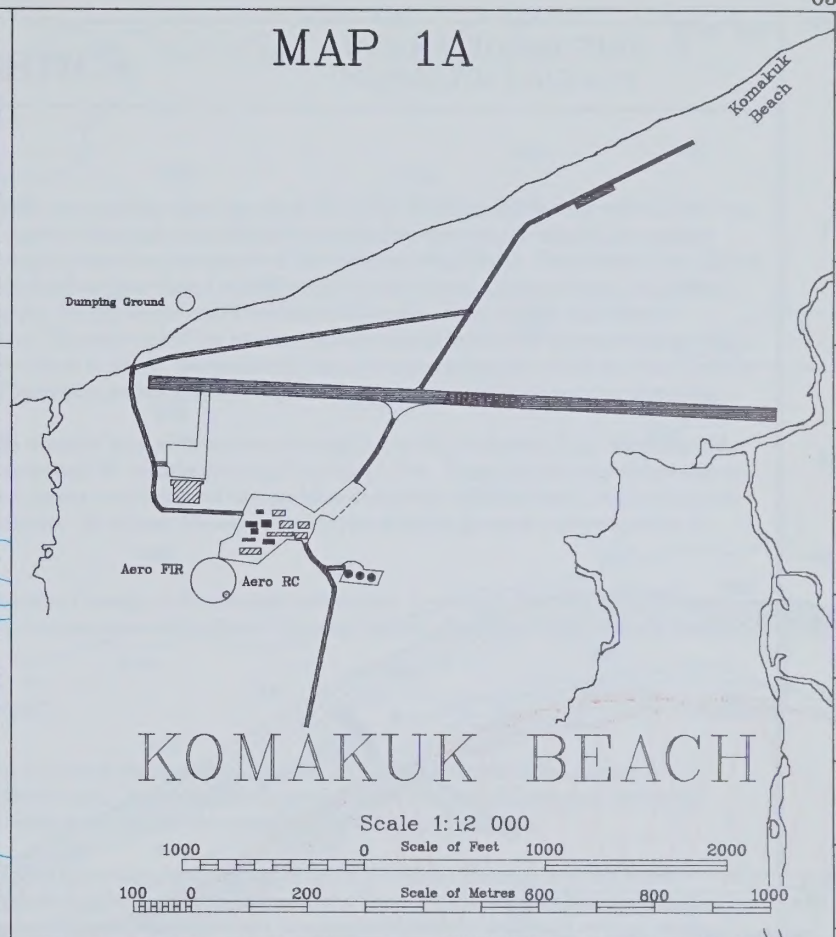


69°45'N

141°00'W

140°30'W

MAP 1A



AREA 1

Clarence R.
Ca1
Clarence Lagoon
F1

AREA 2

F2

AREA 3

F3

MAP
1A

Komakuk Beach

Fish Creek

Blackhouse R.

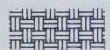
Craig Cr.

USA (Alaska)
CANADA (Yukon)

PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 2 NUNALUK LAGOON

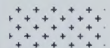
Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Komakuk Beach, Map 1

Hydrographic Chart - 7661

Video Tapes - AGC 9, 10, Dome 2, 3

Access:

Access through the western and middle openings along Nunluk Spit is possible with vessels having a draft of 1 m or less. Navigation through these channels is aided by clear water: shoals are spotted easily. Protected anchorage is found on the leeward side of the extreme west island. Stay close to the island, as the water is extremely shallow (less than 1 m) towards the river delta. Channels may be present, but are difficult to navigate. Barge access onto the seaward beaches of the middle and western barrier islands is possible. The east end of the western barrier island has a very steep gradient with a channel depth of 2 m very close to shore. Barge access onto the eastern barrier island may be possible from the western end. Floatplane access into this region is variable and depends on pilot discretion.

The passage through the western inlet of Workboat Passage has a depth of about 2 m. Markers aid navigation through this passage for vessels drawing less than 1.5 m. Barge access onto either side of Avadlek Spit is possible. Access onto the sand barrier island opposite Avadlek Spit is difficult due to shallow depths and gradients. Workboat Passage provides good landing access and protection for floatplanes.

Lopez Point, inside Workboat Passage, is the nearest safe anchor for vessels drawing 1.5 m or less. Pauline Cove (Map 3), 40 km east around northern Herschel Island, offers good anchorage in depths to 5 m.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

Prevent oil from entering the important bird staging areas of Workboat Passage and the lagoon behind Nunluk Spit. Incoming oil may be diverted onto the barrier spits, where skimmers and pumps may be used to collect the oil. Four openings between spits should be sealed, of total width 2625 m. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

The shoreline in this area is composed primarily of sand and gravel beaches on the barrier spits, with tundra shoreline in the areas behind the spits. Exposed gravel beaches that are not heavily oiled may not require active cleaning. Access points for delivering cleanup machinery are noted for Nunluk and Avadlek spits. Potential disposal sites are identified at the foot of Nunluk Spit and on Herschel Island. As access to the Nunluk site may disturb a nearby archaeological site, a recommended alternative is to transfer debris, by winter ice road, to the Fish Creek site (10 km to the west).

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 2 NUNALUK LAGOON

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

4	Nunaluk Spit	82.25
5	Avadlek Spit	34.70
6	Workboat Passage	89.45

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

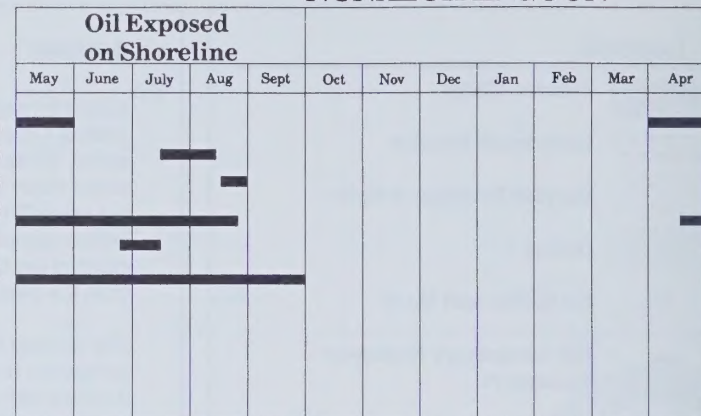
Reindeer Re or Caribou Ca

Fish

Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use



Environmental Description:

R 4, 5, 6 Heritage sites identified by regional residents contribute to the sensitivity of this area. Polar bear are hunted at the northwest end of Workboat Passage in April and May. Areas 4 and 6 lie within the Northern Yukon National Park. Area 5 lies within the Herschel Island Territorial Park.

DL 4, 6 From mid July to mid August, thousands of moulting (flightless) and feeding diving ducks congregate in Nunaluk Lagoon and in Workboat Passage (3).

SC 6 From mid to late August, thousands of shorebirds stage (concentrate to feed) along the east side of Avadlek Spit (3).

AF 4, 6 Arctic fox dens are concentrated along this section of the Yukon coastline (4). These dens are reused from year to year (5) and are occupied from late winter/early spring through late summer (6). In fall and winter, foxes move long distances on the sea ice in search for food (7) and may scavenge the carcasses of seals killed by polar bears (8).

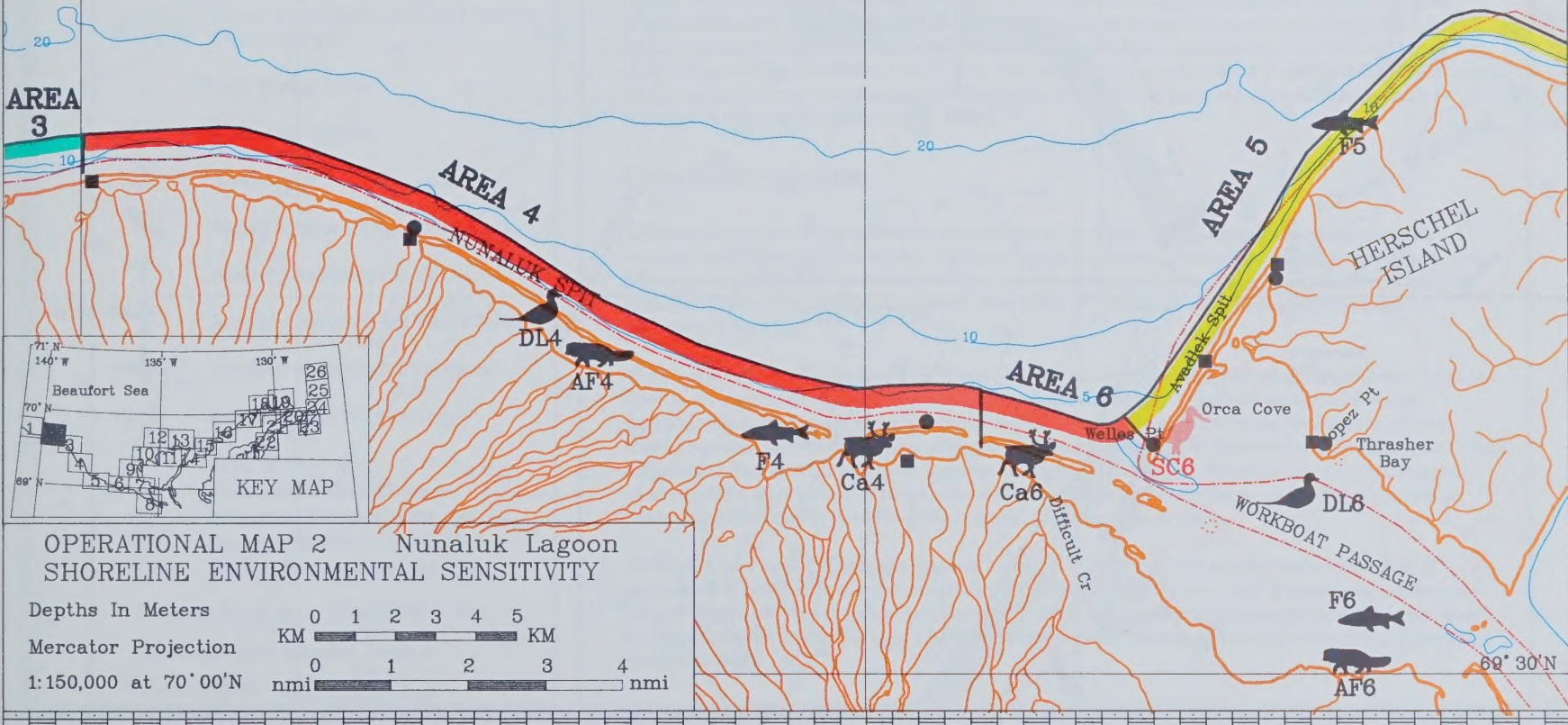
Ca 4, 6 A significant portion of the Porcupine caribou herd uses areas adjacent to the mouth of the Firth River in some years (24).

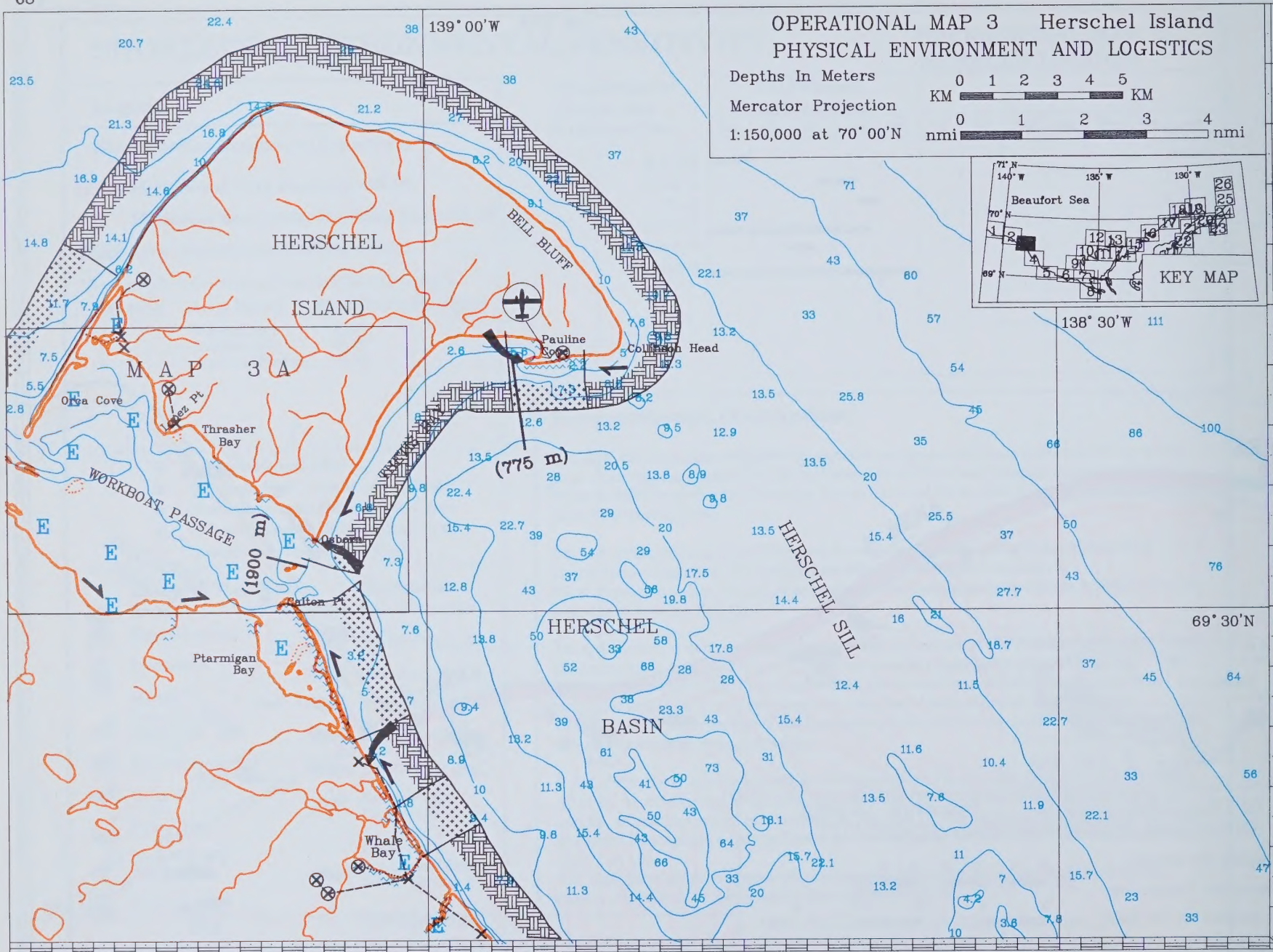
F 4, 6 Firth River has the largest Yukon population of Arctic char (approximately 32,000 - 40,000). Arctic char are likely to be abundant near the river mouth at peak migratory periods, at breakup and in mid summer to late fall (1). The lagoon behind Nunaluk Spit and Workboat Passage are important summer feeding areas for Arctic and least cisco and Arctic char (1, 9, 10).

F 5 Nearshore areas are important summer feeding areas for marine and anadromous species and migration corridors for cisco and whitefish (1).

140°00'W

139°30'W





PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 3 HERSCHEL ISLAND

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7661

Video Tapes - AGC 9, Dome 3, 4

Access:

The 5 metre contour lies about 400 m offshore along Herschel Island and the mainland coast. Approach Pauline Cove from westwards. Pauline Cove offers good anchorage in depths to 5 metres, with a soft mud bottom and good shelter, except from the southwest. A normal tidal variation of up to 0.4 m is reported for Herschel Island. Pauline Cove offers good landing access and protection for floatplanes, and winter airstrips have been built on the ice for larger craft. Fresh water is available from small lakes in the hills NE of Pauline Cove. Thetis Bay, while not protected from easterlies or south-easterlies, provides depths of 7 to 11 m.

Navigation through the eastern inlet of Workboat Passage is aided by markers, but is restricted to vessels having a draft less than 1.5 m. Two small islands and a rock lie in less than 1.8 m of water off the southern tip of Osborne Point. This channel can be dangerous when the tidal current opposes strong winds, conditions that result in steep and closely spaced waves. Access for beaching craft onto either side of Osborne or Calton spits is possible because of steep shoreline gradients.

Inside Workboat Passage, along the southern shore of Herschel Island, shelter is provided from northwest or northeast winds. Lopez Point offers safe anchorage for vessels drawing up to 1.5 m of water. A narrow (60 m) channel into Ptarmigan Bay has been reported with a uniform depth of 1 m and swift currents. Depths of 1.5 to 1.8 m exist in the northern portion of Ptarmigan Bay. Protected anchorage in 1.2 m of water can be found directly behind (southeast side) the sand spit which is situated in the middle of Ptarmigan Bay.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Pauline Cove is a protected anchorage during foul weather, and offers an excellent base for nearshore countermeasures operations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

Workboat Passage, Thetis Bay and Whale Bay are all identified as having high sensitivity. Pauline Cove is an important fishing camp and archaeological site that should be protected from oil contamination. Although complete protection of all sensitive areas may not be possible, efforts should be made to divert incoming slicks to less sensitive areas (i.e., the tundra cliffs on the north side of Herschel Island, and the gravel beaches bordering Whale Bay). Skimmers and pumps may be used to collect diverted oil. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Exposed gravel and cliff beaches that are not heavily oiled may not require active cleaning. If excavation of beaches is carried out or oiled debris is collected, a potential disposal site is identified behind Whale Bay: care should be taken not to disturb a nearby archaeological site. This site may not be acceptable due to the area's National Park status; the closest alternative is 40 km distant via winter ice road.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 3 HERSCHEL ISLAND

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

5	Avadlek Spit	34.70
6	Workboat Passage	89.45
7	North Herschel Island	49.00
8	Thetis Bay	71.30
9	Whale Bay	68.95

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

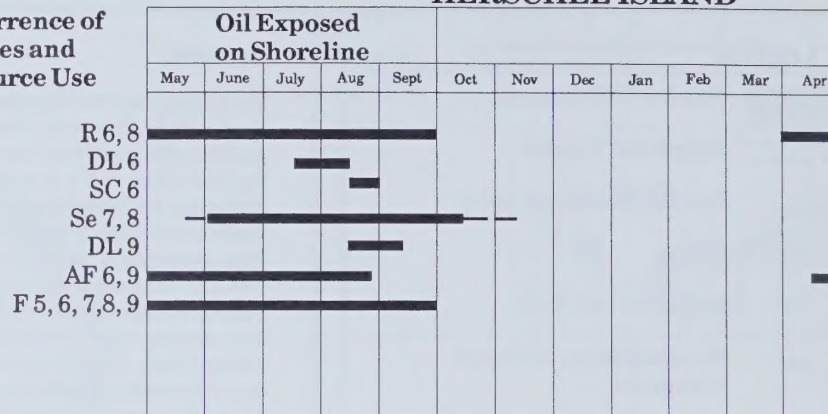
Reindeer Re or Caribou Ca

Fish

Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use



Environmental Description:

R 6, 8 The Pauline Cove-Simpson Point area is of great importance to regional residents for both its historic significance and its present value for resource harvesting. It is currently used by residents of Aklavik as a fish camp in the summer and for polar bear and seal hunting in April and May. The northern end of the Calton Point spit is also used for these purposes (11). In addition to the heritage sites identified on Herschel Island and Calton Point, there are 6 federally identified archaeological sites along the coast from Ptarmigan Bay to Whale Bay. Herschel Island has been designated a territorial park, and areas 6 and 9 along the Yukon coast lie within the Northern Yukon National Park.

DL 6 From mid July to mid August, thousands of moulting and feeding diving ducks congregate in Nunaluk Lagoon and in Workboat Passage (3).

SC 6 From mid to late August, thousands of shorebirds stage along the east side of Avadlek Spit (3).

Se 7, 8 From June through September, less than 50 breeding, feeding and moulting black guillemots congregate in coastal areas from Collinson Head and Pauline Cove to Osborn Point. This is the only major breeding concentration of this species in the Canadian Beaufort Sea (3, 12).

DL 9 From mid August to mid to late September, thousands of diving ducks stage in coastal waters from Whale Bay and Roland Bay to Stokes Point.

AF 6, 9 Arctic fox dens are concentrated along this section of the Yukon coastline (4). These dens are reused from year to year (5) and are occupied from late winter/early spring through late summer (6). In fall and winter, foxes move long distances on the sea ice in search for food (7) and may scavenge the carcasses of seals killed by polar bears (8).

F 5, 7, 9 Nearshore areas provide important summer feeding habitat for marine and anadromous species and migration corridors for cisco and whitefish (1).

F 6, 8 Large numbers of Arctic cisco, least cisco and Arctic char are known to occur in Workboat Passage and Pauline Cove. The relative abundance of these species in catches has varied considerably among surveys (10).

OPERATIONAL MAP 3 Herschel Island SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

Mercator Projection

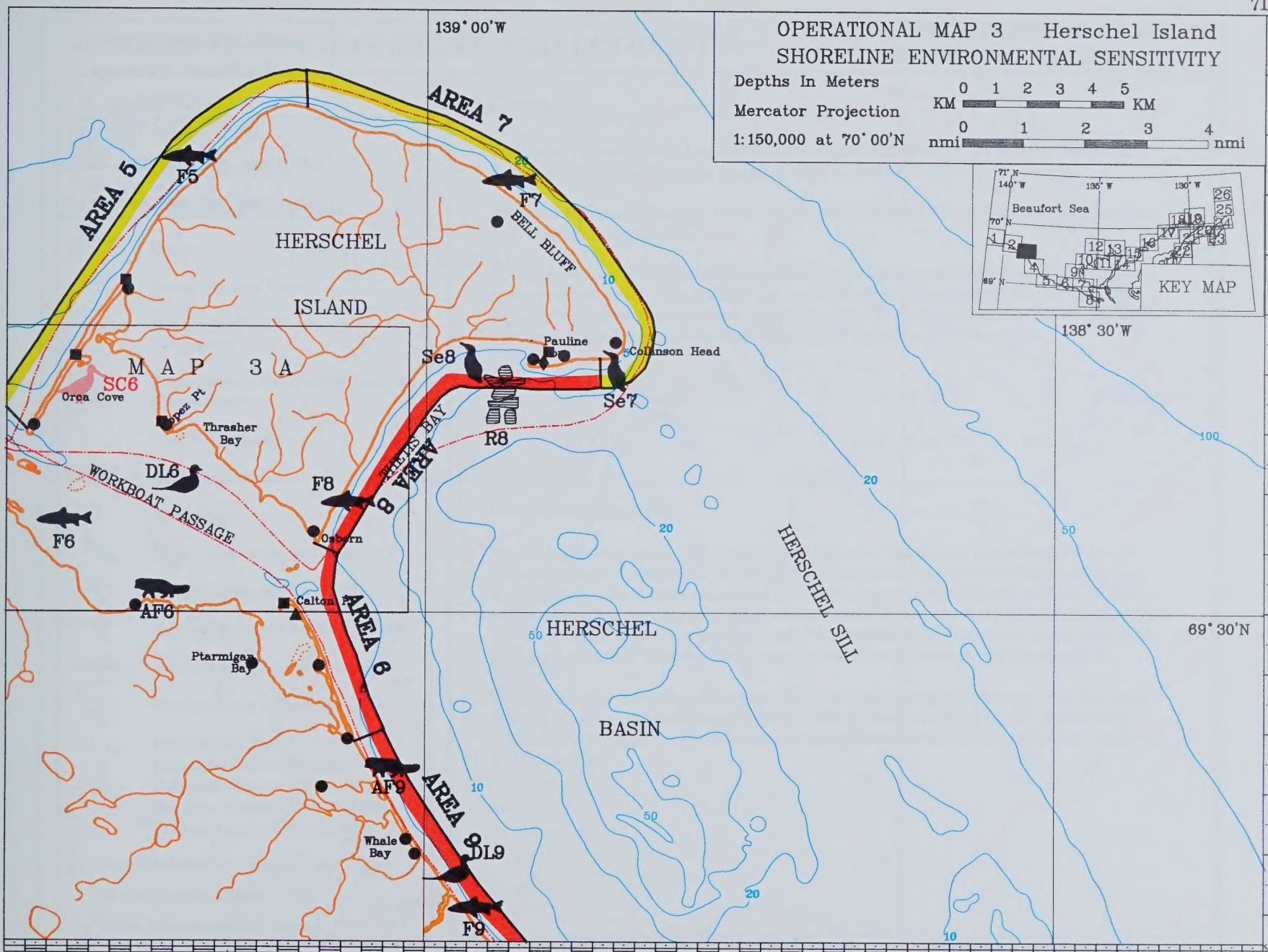
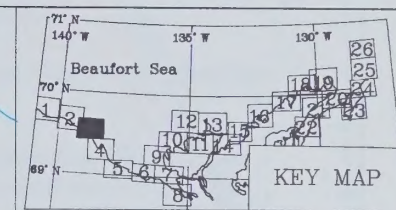
1:150,000 at 70° 00'N

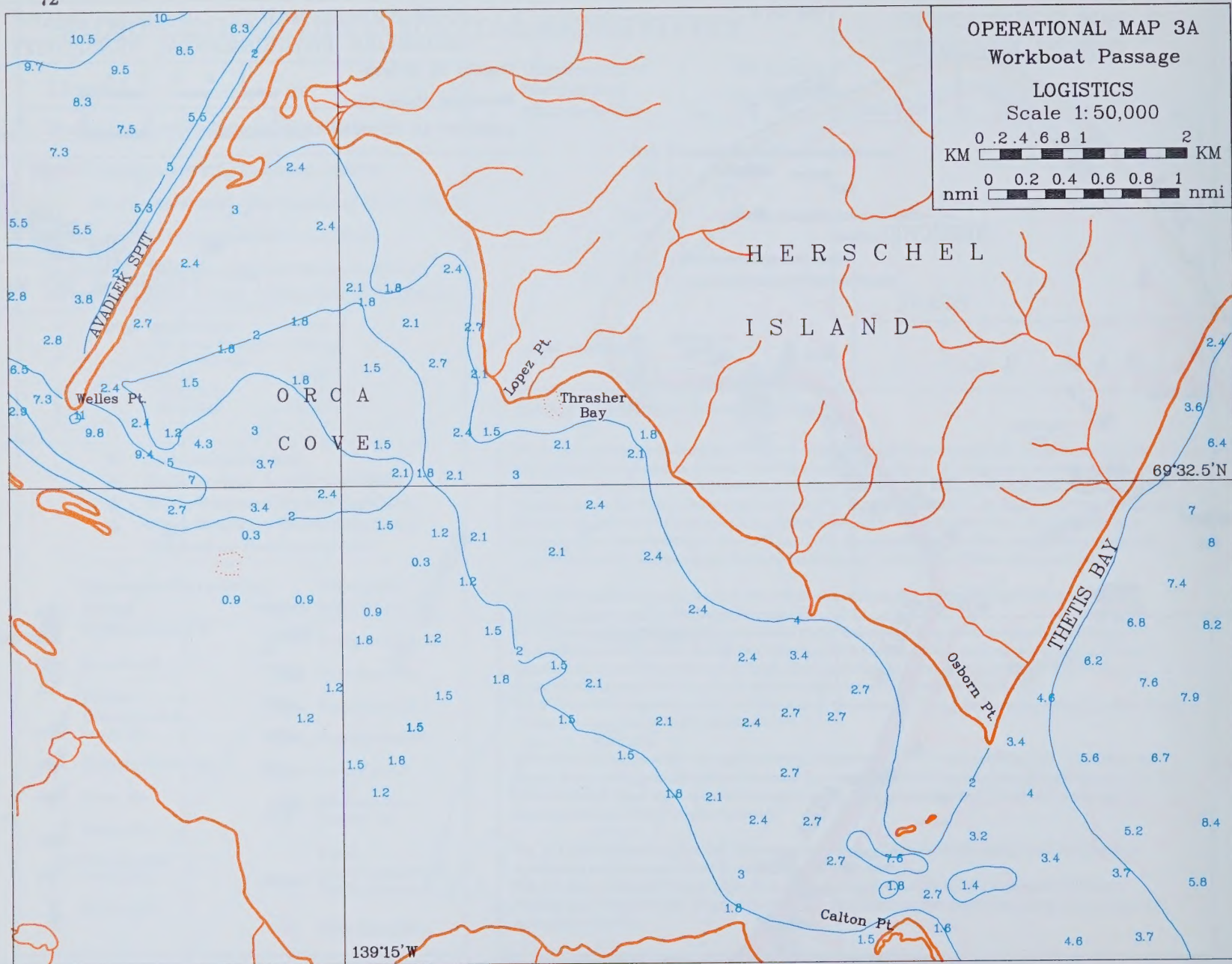
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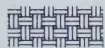
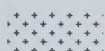
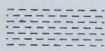




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 3A WORKBOAT PASSAGE

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7661

Video Tapes - AGC 9, Dome 3

Access:

Workboat Passage is shallow, particularly on its south side. It is reported that vessels drawing 2 m can navigate the passage safely at normal water levels.

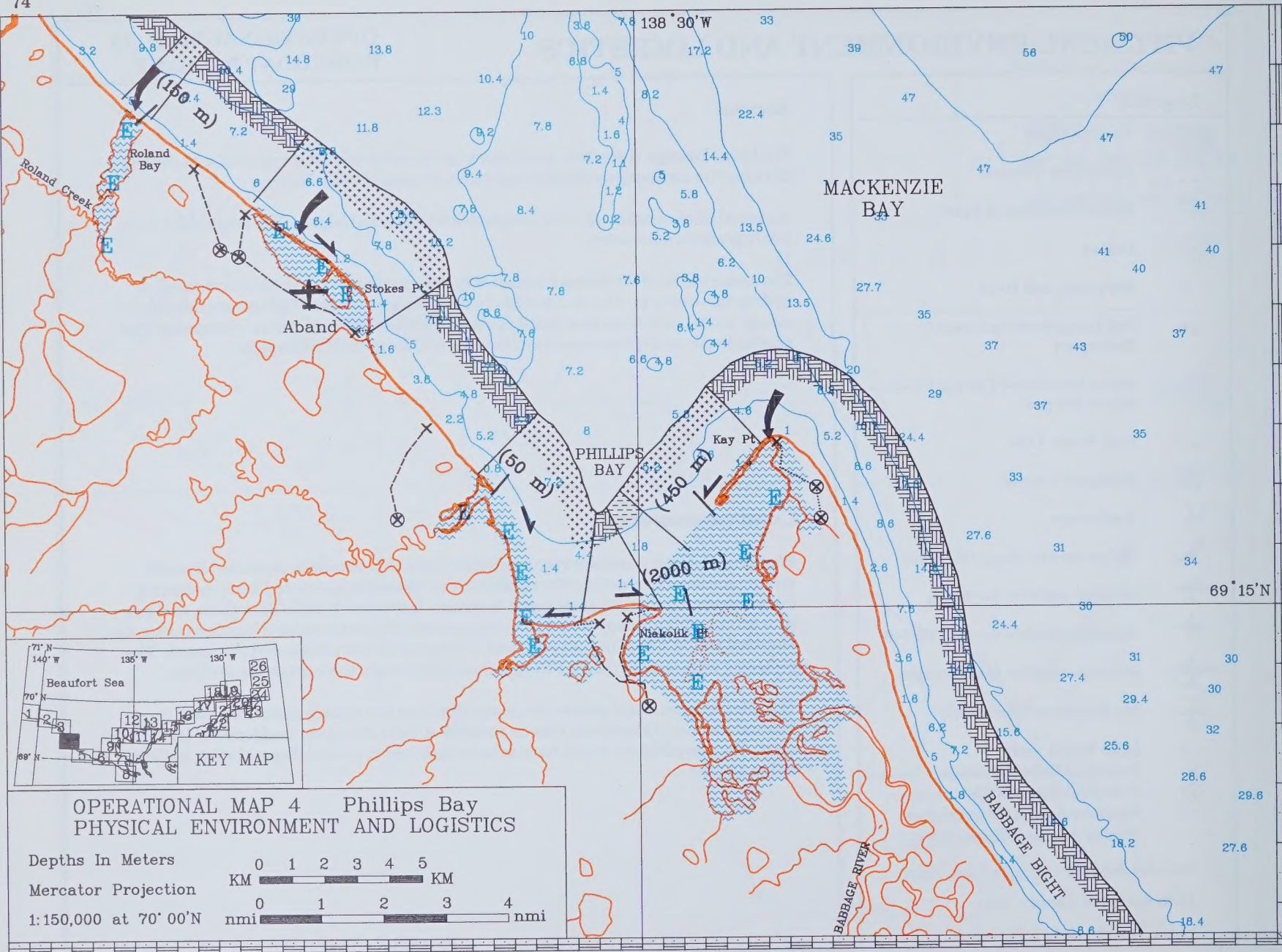
A normal tidal variation of 0.4 m is reported for Herschel Island. The magnitude of the tidal current is not known.

The eastern inlet of Workboat Passage may have depths less than those indicated on hydrographic charts. The channel can be dangerous when the tidal current opposes strong winds, conditions that result in steep and closely spaced waves. Steep shoreline gradients allow barge access onto either side of Osborn and Calton spits.

Countermeasures:

Workboat Passage is an important waterfowl area that should be protected from oil contamination. Oil entering Workboat Passage should be prevented from contacting the southerly side of the passage as it is tundra, is extremely difficult to clean, and has poor access. One strategy would be to concentrate slicks at protected locations along the Herschel Island side of the passage, and to recover oil with pumps and skimmers. The protected waters of Workboat Passage should allow effective containment efforts.

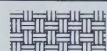
The relatively protected waters also mean that beached oil may persist for some time. Manual cleanup of shorelines may be possible at locations along the Herschel Island coast. Recovered debris would have to be transferred to remote disposal sites, as far as 40 km distant.



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 4 PHILLIPS BAY

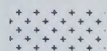
Legend



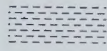
Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7661

Video Tapes - AGC 8, 9, Dome 3, 4

Access:

Relatively deep water can be found close to the shoreline in this region facilitating barge access to the beach. The 5 metre contour lies about 400 m offshore. Steep offshore gradients at Roland Bay and Stokes lagoon allow access for shallow draft barges. Roland Bay and Stokes lagoon offer good landing access and protection for floatplanes.

At Stokes Point equipment can be offloaded at a landing beach situated eastward of the oil tanks. Access is suitable for landing craft with a maximum draft of 1.2 m. A road leads from the beach to the abandoned DEW line station. The unmaintained 1,066 metre airstrip, about 1 km southwest of the buildings, should not be used. Instead an airstrip northeast of the buildings, along the beach, is adequate for landing DC3's in the summer and fall. The south end of the strip is soft but the rest is in good condition. A shoal 4.0 km long running north-south, and 1.2 km wide, lies 6.5 km northeastward of Stokes Point. Depths as little as 0.3 m occur. Boat access into Stokes lagoon is restricted to vessels drawing less than 1 m, but can be variable from year to year.

Shallow draft barges can be beached into Kay Point Spit at the northeastern end. The lagoon behind Kay spit is 1 to 1.2 m deep. The depth across the 2,000 metre inlet is 1 m with a very narrow 2 m deep channel, 400-500 m south of the spit. Access onto Niakolik Point can be made with small boats (0.5 m draft or less). The lagoon at the southwest corner of the bay has depth between 0.9 and 1.8 m at the entrance, with general depths of 0.9 m in its southern part. Anchorage for small boats in fine weather is possible, but the spit floods in bad weather. Landing access and protection for floatplanes can be variable and must be left to pilot discretion. The ocean side of Kay Point spit in Phillips Bay offers safe anchorage for vessels having a draft of 3 m, if winds are from the east. The nearest safe anchorage for all winds can be found at Pauline Cove (35 km northwest) for good anchorage in depths to 5 metres.

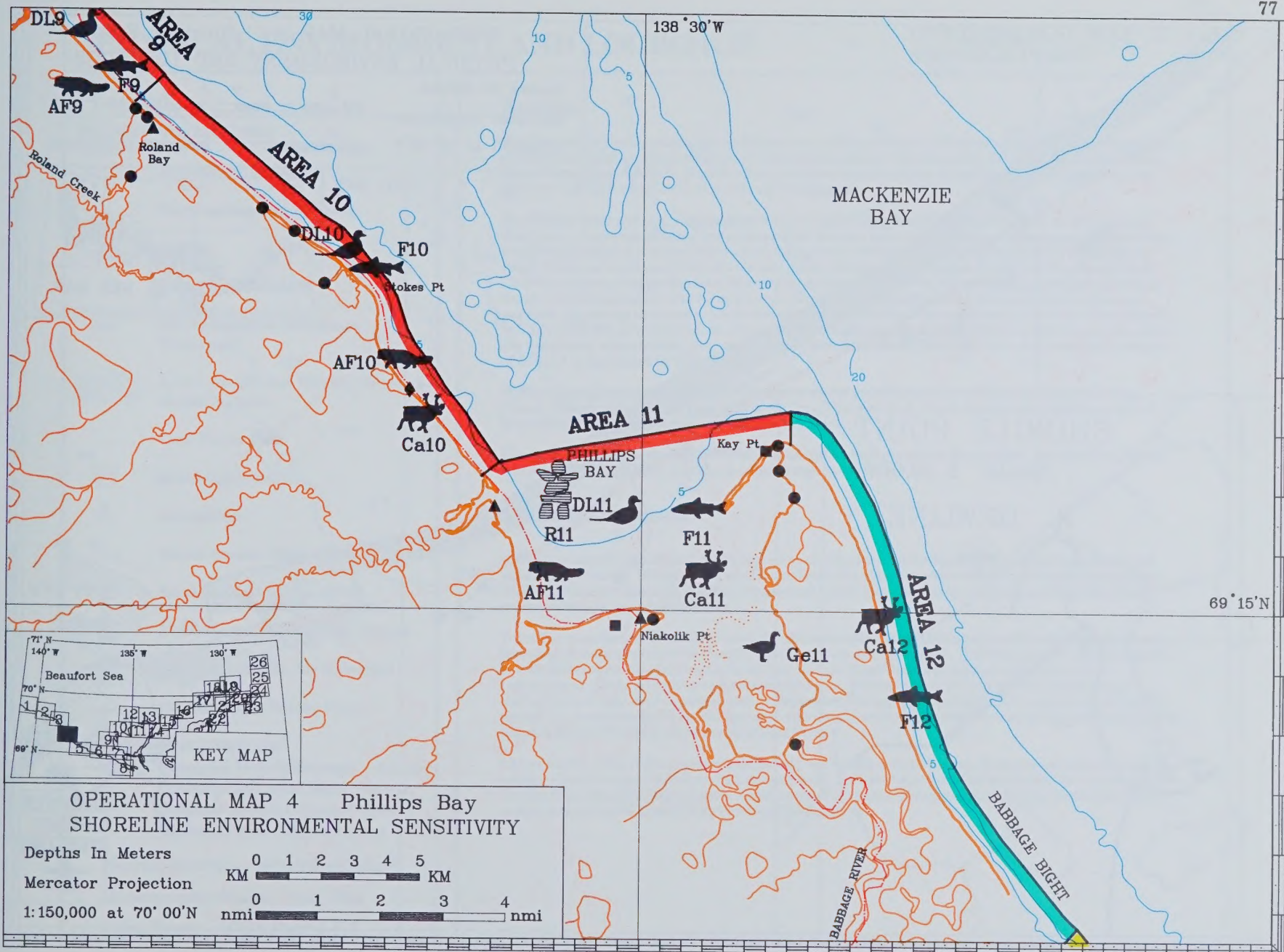
Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Reefs off Stokes Point present a hazard to vessels. Phillips Bay affords some protection as a short-term anchorage. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

Phillips Bay and Stokes Point are high priority areas for protection. Slicks approaching Phillips Bay could be diverted to the less sensitive cliffs immediately west of Spring River; skimmers and pumps could be used to collect diverted oil. As a minimum, the 2000 m opening between Niakolik Point and Kay Point Spit could be sealed with deflector booms, thus protecting the Babbage River delta. Oil should be prevented from entering Stokes lagoon: should the barrier spit be breached, deflector booms may be used to seal the opening. If threatened, the inlet to Roland Bay should be sealed. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Cliff and gravel beaches of low sensitivity may not require active cleaning, depending on the degree of contamination. Several specific locations are noted for delivering cleanup machinery. Potential disposal sites for recovered debris and sediments are identified near Stokes Lagoon, Spring River and Niakolik Point; all, however, are in Northern Yukon National Park.

An alternative site near Kay Point may be accessed during summer or winter: care must be taken to locate the site above the zone of possible storm surge inundation, and not to disturb nearby archaeological sites.



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 5 SHINGLE POINT

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7661, 7662

Video Tapes - AGC 8, Dome 4, 5, 6

Access:

The 5 metre contour lies about 250 m offshore, west of Shingle Point. Offshore depths at King Point are great in comparison to other areas, facilitating easy barge access onto the ocean side of the spit. King Point lagoon has no access from seaward. Depths within the lagoon vary little from 3.0 m. The spit that extends across Harbour Lagoon is about 15 m wide at its narrowest point.

The Shingle Point spit forms the seaward side of a sheltered harbour suitable for small boats drawing less than 1.5 m. Care must be taken when entering the harbour as shoals 1.5 m deep exist between Shingle Point and Escape Reef. A 2.1 metre deep channel, 0.8 km east of Shingle spit, provides access into the harbour. Fresh water can be obtained from a creek that enters the harbour at the base of the spit. The Shingle Point DEW line station, 3 km to the east of Running River delta, has a gravel ramp with deadmen embedded in it. Barges can be beached in 1.5 to 1.8 m of water. Shallow water depths extend for a considerable distance seaward. Soundings on a course of 218° towards the beach oil tanks decrease from 1.8 m when 5 km offshore, to 1.2 m when 925 m from the tanks. Strong winds will affect water depths. West and northwest winds raise the water level, whereas east, northeast and southeast winds lower the water level. A normal tidal variation of up to 0.4 m is reported for Shingle Point.

A 1,160 metre gravel airstrip suitable for year-round use parallels the head of Trent Bay (map 6), 1.0 km inland. Winter airstrips have been built on the ice at Shingle Point. Fresh water is available from a lake 5 km south of the site; a road connects the lake and beach.

Good anchorage can be obtained in 2.4 m of water on the southern side of Escape Reef. Pauline Cove, 90 km northwest of Shingle Point provides good anchorage in depths to 5 m.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Shingle Point and Escape Reef offer some protection as potential bases of operations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

Trent Bay is unlikely to be totally protected in the event of incoming slicks; one possible strategy is to divert incoming oil to the gravel and cliff beaches on the western edge of the bay. Collection devices could be used to recover diverted oil. Considering the important Shingle Point/Trent Bay area as a whole, diversion techniques are likely to be effective for small slicks only; for large slicks, the only practical protection method is at- or near-source containment or dispersion. The lagoon near King Point is protected by a spit; if the spit has been breached it should be sealed with boom (moderate priority). Incoming oil could be diverted to less sensitive cliff beaches on either side of King Point.

Unless heavily oiled, cliff and gravel beaches may not require active cleaning. Barge access points are noted for the delivery of shoreline cleanup equipment. Collected debris and sediment may be transferred to the identified potential disposal sites. Access to these sites should be routed in such a way as to not disturb nearby archaeological sites at King Point and Sabine Point.

F 13, 14, 15, 16 Nearshore areas are important migration corridors and provide summer feeding habitat for anadromous fish. Large numbers of fish have been reported at Shingle Point during summer. Protected areas such as King Point and Shingle Point are also important rearing areas for Arctic and least cisco and to a lesser extent for Arctic char and humpback whitefish (1).

OPERATIONAL MAP 5 Shingle Point SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

Mercator Projection

1:150,000 at 70°00'N

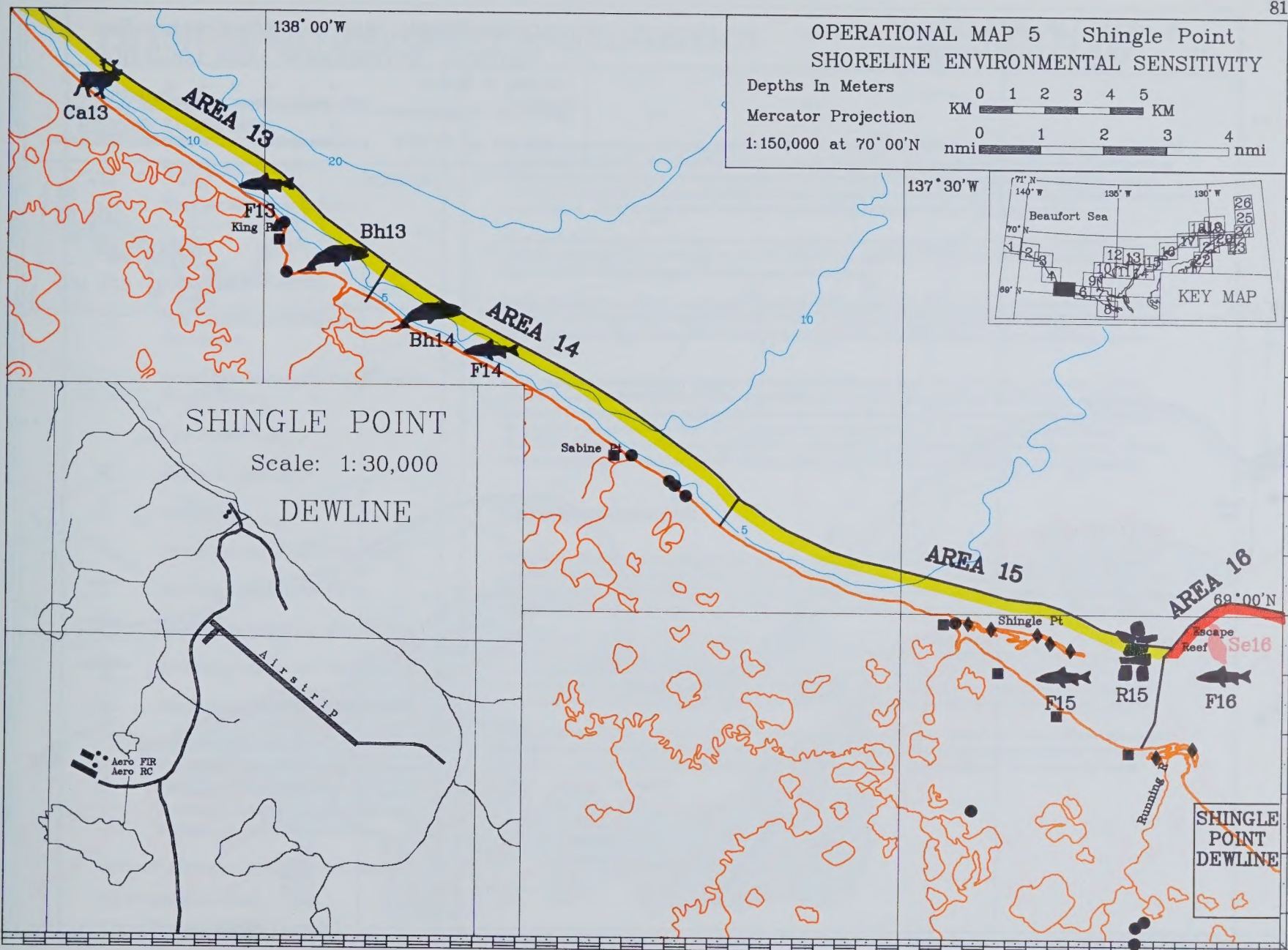
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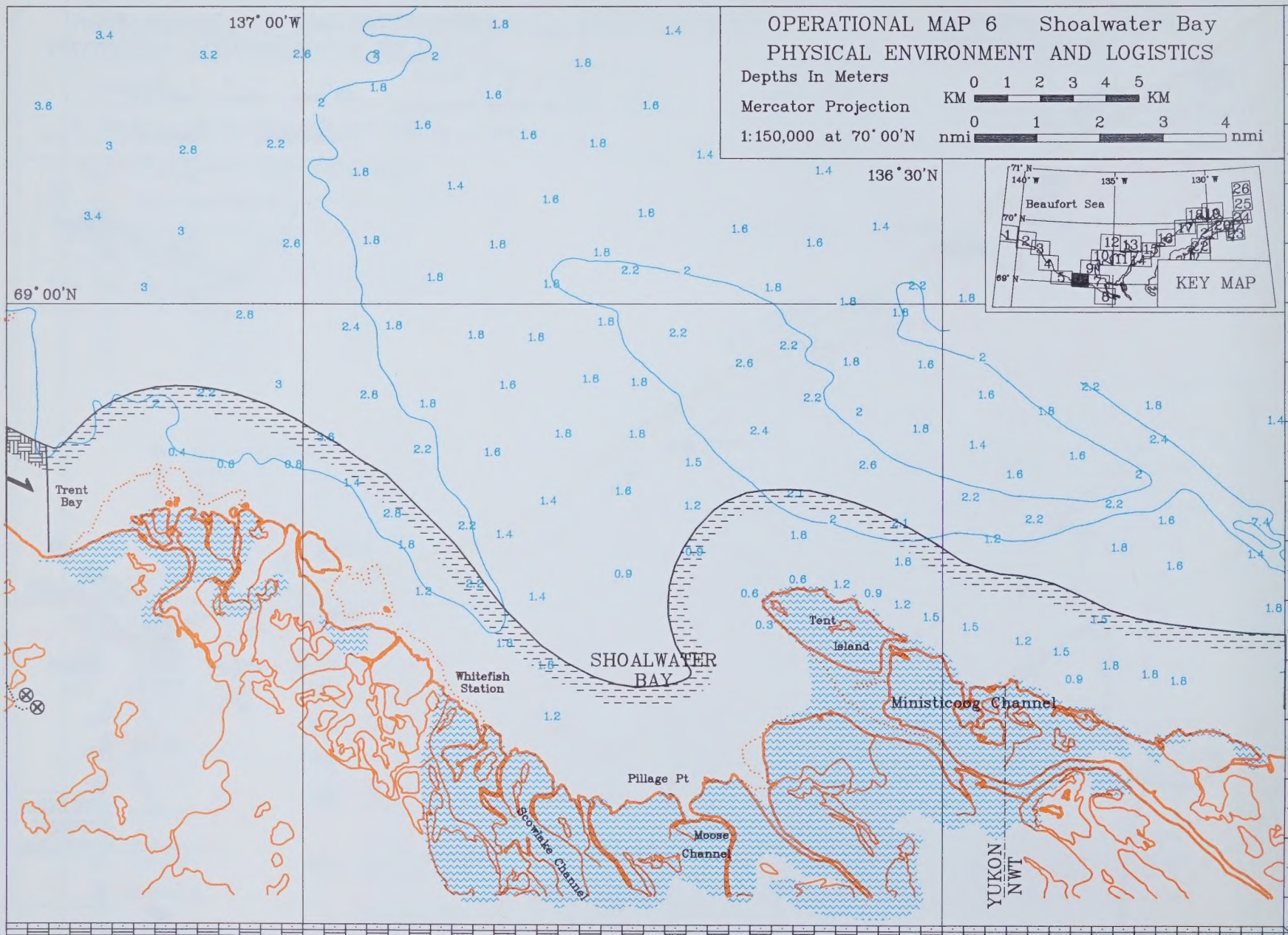
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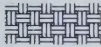




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 6 SHOALWATER BAY

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
E	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7662

Video Tapes - AGC 8, Dome 6, 7

Access:

Shoreline protection and cleanup systems may need to be deployed by helicopter in this region, as access to the shoreline by boats drawing less than 0.5 m is nearly impossible. Extensive mud flats fronting the Blow River delta and east side of Shoalwater Bay make shoreline access difficult and dangerous during strong winds. Local people staying at Niakunuk and Bird Camps during the summer should be consulted if these waters are to be navigated. Their knowledge of local conditions will facilitate protection and cleanup plans.

Strong winds have a great influence on water depth in this region; easterly winds lower the water level, whereas westerly winds raise the water level. A current, apparently due to the outflow from the Blow River, appears to set constantly west between 1 and 3 km offshore.

Moose Channel is used by vessels bound for Aklavik from the west. Navigation by vessels drawing more than 1 m is not recommended unless during high water in the spring. There is good landing access and protection for floatplanes at Bird Camp and Whitefish Station (Niakunuk). Trent Bay is a suitable landing site for floatplanes.

Anchorage can be obtained in 2.4 m on the south side of Escape Reef. Shingle Point, 30 km west, offers a sheltered harbour for small boats drawing less than 1.5 m. Reindeer Channel, 45 km east, provides good shelter. The channel is buoyed but is reported to have shallowed in the last few years. Navigation of the channel by vessels drawing more than 1 m is not recommended unless during high water in spring. The dates of freeze-up and break-up in Mackenzie Bay are widely variable. The navigation season, usually opening in July and lasting until late September, is sometimes delayed by heavy ice until late August.

Countermeasures:

Offshore countermeasures, dispersion or containment for recovery or in-situ burning, represent the only practical method of protecting the extensive tundra shorelines in the vicinity of Shoalwater Bay. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats. Note that the low salinity waters in this area may reduce dispersant effectiveness.

The vast majority of the shoreline is deltaic tundra and has a long oil persistence potential. Diversion efforts are not likely to be practical for the entire area except for small slicks. Efforts should be concentrated on protecting specific areas such as the major harvesting camps and the bird staging areas. Small to moderate sized slicks may be concentrated at various locations for recovery with pumps and skimmers. The shallow nearshore waters in this area may dictate the deployment of equipment by helicopter rather than by boat.

The delta shoreline in this area is not amenable to mechanical cleanup. Small-scale manual operations may be carried out at certain locations as may be required. The only potential disposal site is located inland of Trent Bay, and would necessitate the transfer of collected debris and/or sediment via ice road in winter.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 6

SHOALWATER BAY

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
16	Trent Bay	84.90
17	Shoalwater Bay	72.50
18	West Channel	51.00

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

- Areas**
Highly Important R

- 
- Important R

Birds

-  Diving Ducks & Loons DL

- 
- Dabbling Ducks DD

-  Geese Ge

- Swans Sw

- 
- Shorebirds &
Cranes SC

- Seabirds Se

Mammals

- 
- White Whale WW

- 
- Bowhead Whale Bh

-
- Polar Bear PB

- 
- Ringed Seal RS

-
- Bearded Seal BS

-
- Arctic Fox AF

- 
- Reindeer Re or
Caribou Ca

Fish

- 
- Anadromous Fish &
-
- Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

Oil Exposed on Shoreline

Source Use	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
R16,17												
Sw 16,17,18												
Ge 16,17,18												
WW17												
Ca 16,17												
F16,17,18												

Environmental Description:

R 16, 17 Trent Bay and Shoalwater Bay areas are among the most important harvesting areas on the coast. Fishing and whaling camps are located on Tent Island, at Niakunak (Whitefish Station) and on Moose Channel, and are used each year during the entire summer (11, 16, 18, 19, 20). This area is also important for caribou and fall bird hunting (11, 16, 17, 20).

Sw 16, 17, 18 From June through September, hundreds of tundra swans breed, rear broods, moult and stage in coastal areas from Trent Bay and the Blow River delta, across Shoalwater Bay to the mouth of the west channel of the Mackenzie River (3).

Ge 16, 17, 18 From mid to late August to late September, tens of thousands of geese stage in coastal areas from Trent Bay and the Blow River delta, across Shoalwater Bay to the mouth of the West Channel of the Mackenzie River (3).

WW 17 In most years, white whales concentrate in Shoalwater Bay for a period of several days during late June to mid July (21, 22, 23). In 1978, approximately 1250 whales (i.e., about 10 percent of the population) were estimated to be in the western half of the bay (21).

Ca 16, 17 During mid July, a significant portion of the Porcupine caribou herd may use the nearshore area between Tent Island and the mouth of Blow River (24).

F 16, 17, 18 Bays along the shoreline are important for summer feeding and migration of anadromous fish from the Mackenzie River. Large numbers of juvenile and adult humpback whitefish have been reported in Trent Bay during July and August (1).

137° 00' W

OPERATIONAL MAP 6 Shoalwater Bay SHORELINE ENVIRONMENTAL SENSITIVITY

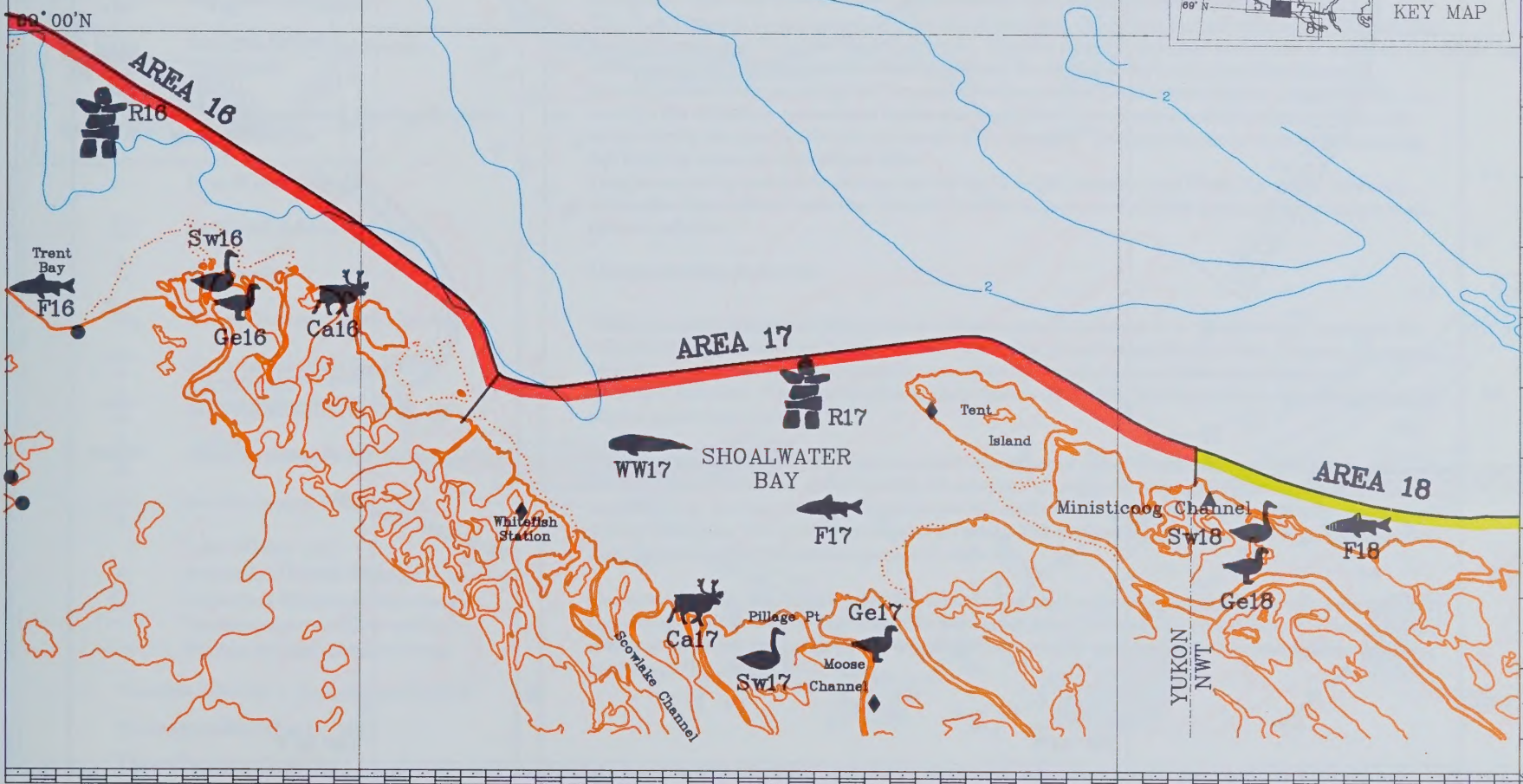
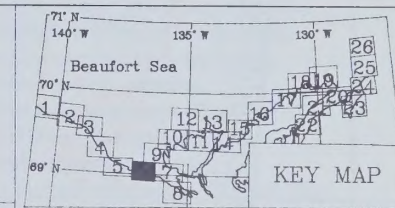
Depths In Meters

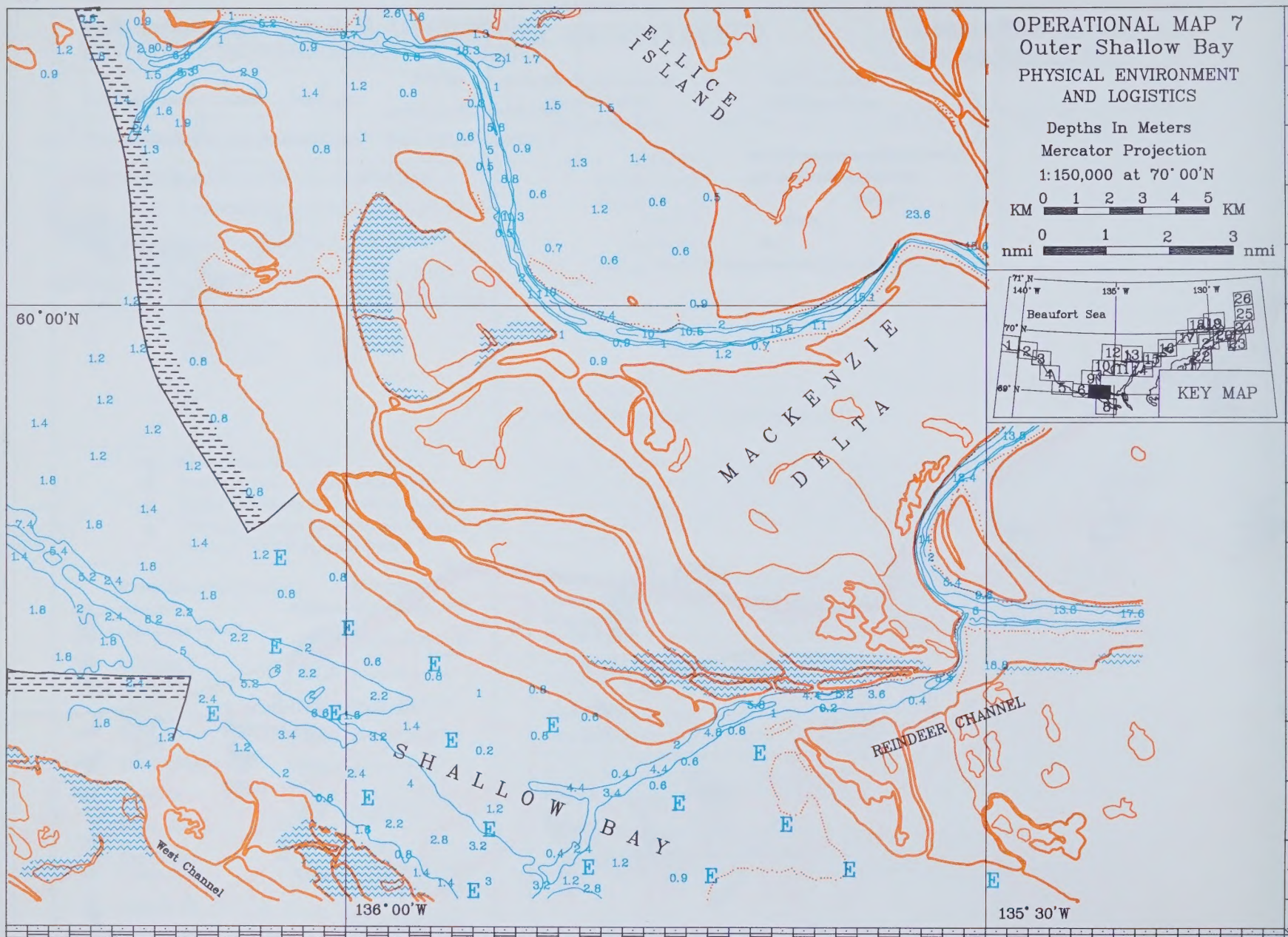
Mercator Projection

1:150,000 at 70° 00' N

0 1 2 3 4 5
KM0 1 2 3 4
nmi

136° 30' N

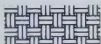




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 7 OUTER SHALLOW BAY

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
E	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7662

Video Tapes - Dome 7, 8

Access:

Shallow draft (1 m or less) boat access throughout this region is extremely variable. Shallows, formed by alluvial deposits, cross the entire mouth of the Mackenzie River delta. Water levels are subject to rapid changes, being influenced by the prevailing winds. Easterly winds lower water levels, while westerly winds raise water levels. In most areas the shoreline cannot be reached by boat, as the bottom has a very undulating topography. Exposed mud flats may occur 2-3 km offshore. Channels are difficult to locate, as bay and channel mouths are similar in appearance. The local people using the summer camps along the coast should be consulted if these channels are to be navigated. Their knowledge of the local conditions will facilitate countermeasures planning. The West Channel is not buoyed. The mouth of Reindeer Channel is buoyed right across Shallow Bay and northwest past Tiktalik Channel (Map 8). Tiktalik Channel has good anchorage in less than 1.0 m and is a much better way of accessing the western Mackenzie delta than is the West Channel. Overnight shoreline camps are not recommended because of the dangers of storm surges. There must be the capability to evacuate people and equipment from these low delta plains on very short notice during the open water season (especially in the fall). Floatplanes can land on river channels, but doing so depends on pilot discretion.

Deep water and protected anchorage can be found inside Reindeer and West Channels. However, navigation from offshore into the channels is difficult because of shallow depths (1 m or less) at the channel mouths.

Countermeasures:

Offshore countermeasures, dispersion or containment for recovery or in-situ burning, represent the only practical method of protecting the extensive delta shorelines of Shallow Bay. Dispersant use is ecologically justified within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats. Note that the low salinity waters of Shallow Bay may reduce the effectiveness of conventional dispersants.

The extensive coastline in this area precludes the effective use of shoreline protection techniques. Specific channels may be sealed to limit the extent of oil contamination, particularly those of importance to bird populations. Normal channel outflows may accomplish this naturally, particularly during the spring when outflows are at their peak. The shallow coastal areas may require helicopter-deployed equipment as boat access may be difficult.

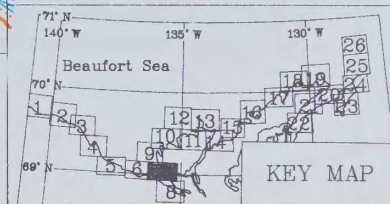
Heavy mechanical shoreline equipment must not be used on tundra shorelines. Small-scale manual cleanup operations may be carried out for particular areas that require rehabilitation. Contaminated debris or sediment would have to be transferred to a remote disposal site: the closest potential site is near Trent Bay, 50 km west.

OPERATIONAL MAP 7
Outer Shallow Bay
SHORELINE ENVIRONMENTAL
SENSITIVITY

Depths In Meters
Mercator Projection
1:150,000 at 70 00'N

KM 0 1 2 3 4 5 KM

nmi 0 1 2 3 nmi



AREA 21

Ge21

F21

R21

R21

AREA 19

Sw19

F19

R21

Ge19

AREA 18

F18

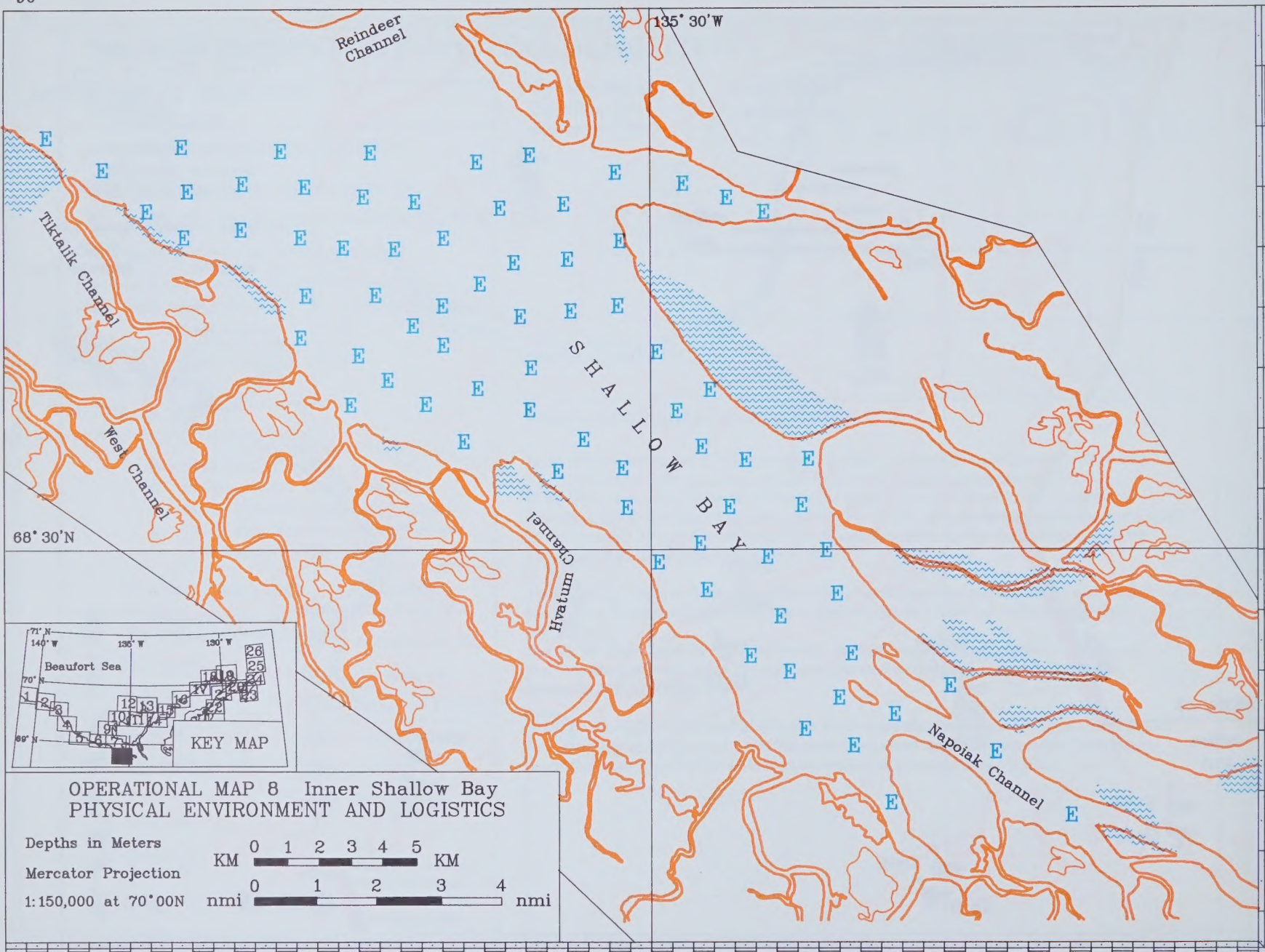
R19

Sw18
Ge18

Sw19
Ge19

Sw19
Ge19

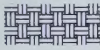
AREA 20



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 8 INNER SHALLOW BAY

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 6433, 6434, 6436, 6441

Video Tapes - Dome 7, 8

Access:

Shallow Bay has a bottom varying from hard sand to soft mud. Mid-channel depths range from 1.5 to 2.0 m. Actual water depths will vary greatly with wind conditions: offshore winds may produce depths up to 0.8 m less than those charted, while onshore winds may increase depths by up to 1.5 m. Exercise great care when approaching the channels at the head of the bay as several sand bars protect the entrance. The low-lying delta lands are susceptible to inundation during storm surges; as such they are not recommended for camps or staging areas.

Tiktalik Channel provides access to the western Mackenzie delta. Reindeer Channel (Map 7) offers protected anchorage for vessels drawing 2 m or less; however, navigating the channel mouth requires great care.

Countermeasures:

Offshore countermeasures represent the only practical method of protecting the tundra shorelines of Shallow Bay. Considering the shape and length of Shallow Bay, and the usual outflow current, oil is unlikely to enter this area from offshore except in the case of persistent northwesterly winds. Dispersant use within the coastal zone is ecologically justified when oil threatens waterfowl concentrations or waterfowl habitats.

All efforts should be made offshore to prevent oil from entering this area as the extensive delta shoreline precludes any practical shoreline protection efforts. If threatened, specific channels could be sealed to limit the extent of upstream shoreline oiling, particularly those of importance to bird populations. Sacrificial zones could be established for the purpose of concentrating oil; incoming slicks could be diverted to these zones for collection with skimmers and pumps.

The low energy environment of Shallow Bay means that beached oil is likely to persist for some time. The delta shoreline is very sensitive and should not be traversed with heavy cleanup machinery. Small-scale manual cleanup may be attempted in certain areas as required.

OPERATIONAL MAP 8 INNER SHALLOW BAY

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
18	West Channel	51.00
19	Outer Shallow Bay	71.25
20	Inner Shallow Bay	71.25

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

- Highly Important R

- ## Important R

Birds

- ## Diving Ducks & Loons DL

- Dabbling Ducks DD

- Geese Ge

- Swans Sw

- Shorebirds & Cranes SC

- Seabirds Se

Mammals

- 
- White Whale WW

- 
- Bowhead Whale Bh

- 
- Polar Bear PB

-
- Ringed Seal RS

- 
- Bearded Seal BS

- 
- Arctic Fox AF

- 
- Reindeer Re or
Caribou Ca

Fish

- 
- Anadromous Fish &
-
- Pacific Herring F

- ### Site Specific

Occurrence of Species and Resource Use

R 19, 20
Ge 19, 20
Sw 19, 20
F 19, 20

[illegible]

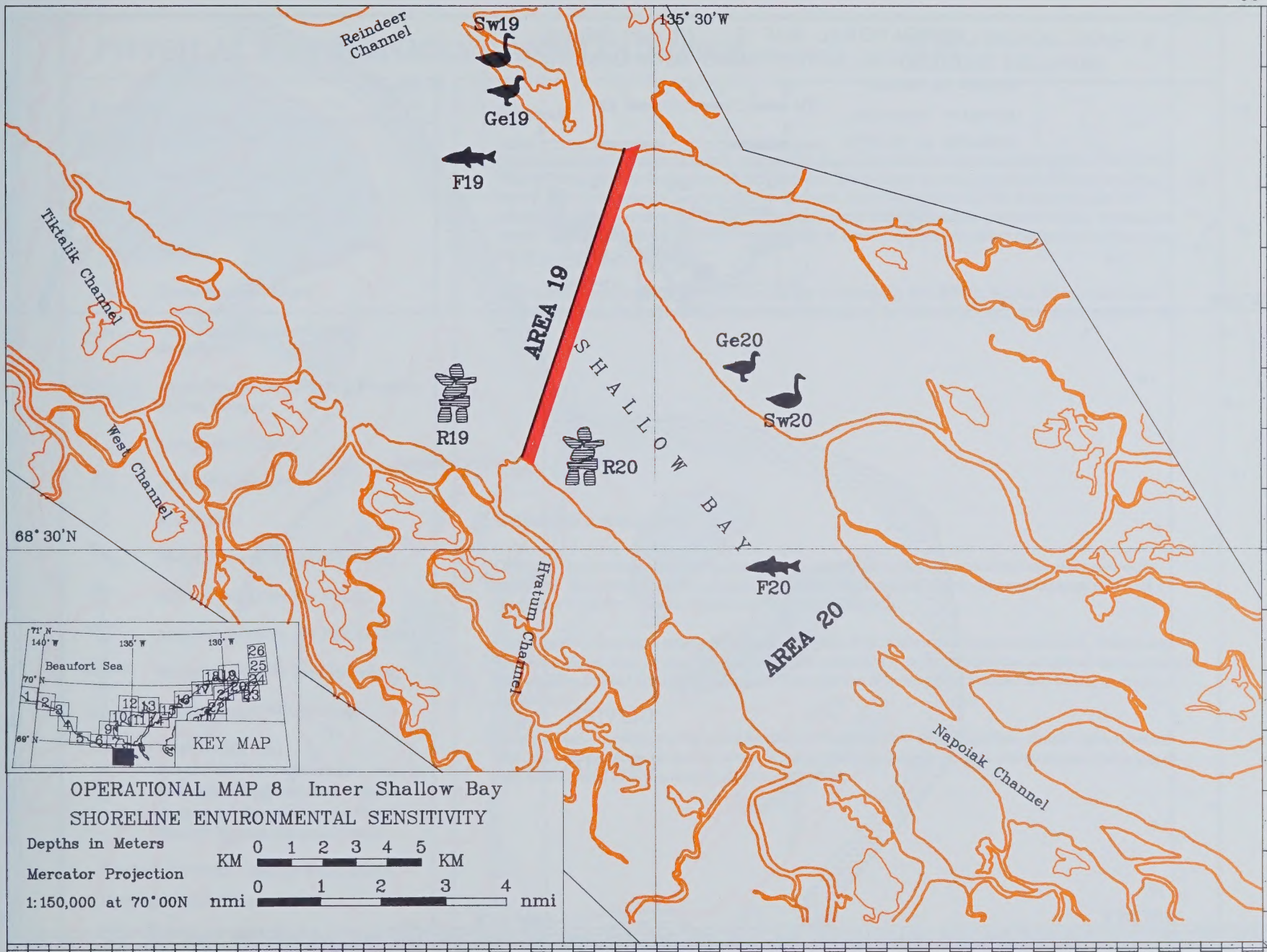
Environmental Description:

R 19, 20 Residents of Aklavik hunt birds along the entire shoreline of Shallow Bay from mid August to September (17).

Ge 19, 20 From mid August to mid to late September, thousands of brant and other geese stage throughout upper and lower Shallow Bay and adjacent wetlands and river channels (3).

Sw 19, 20 From June through September, hundreds to thousands of tundra swans nest, rear broods, moult and stage throughout upper and lower Shallow Bay and adjacent wetlands and river channels (3).

F 19, 20 Shallow Bay and Mackenzie River channels are important migration corridors for Arctic and least cisco and whitefish populations that spawn and overwinter upstream. Some fish may overwinter in the delta in areas where ice is not grounded (1, 25).

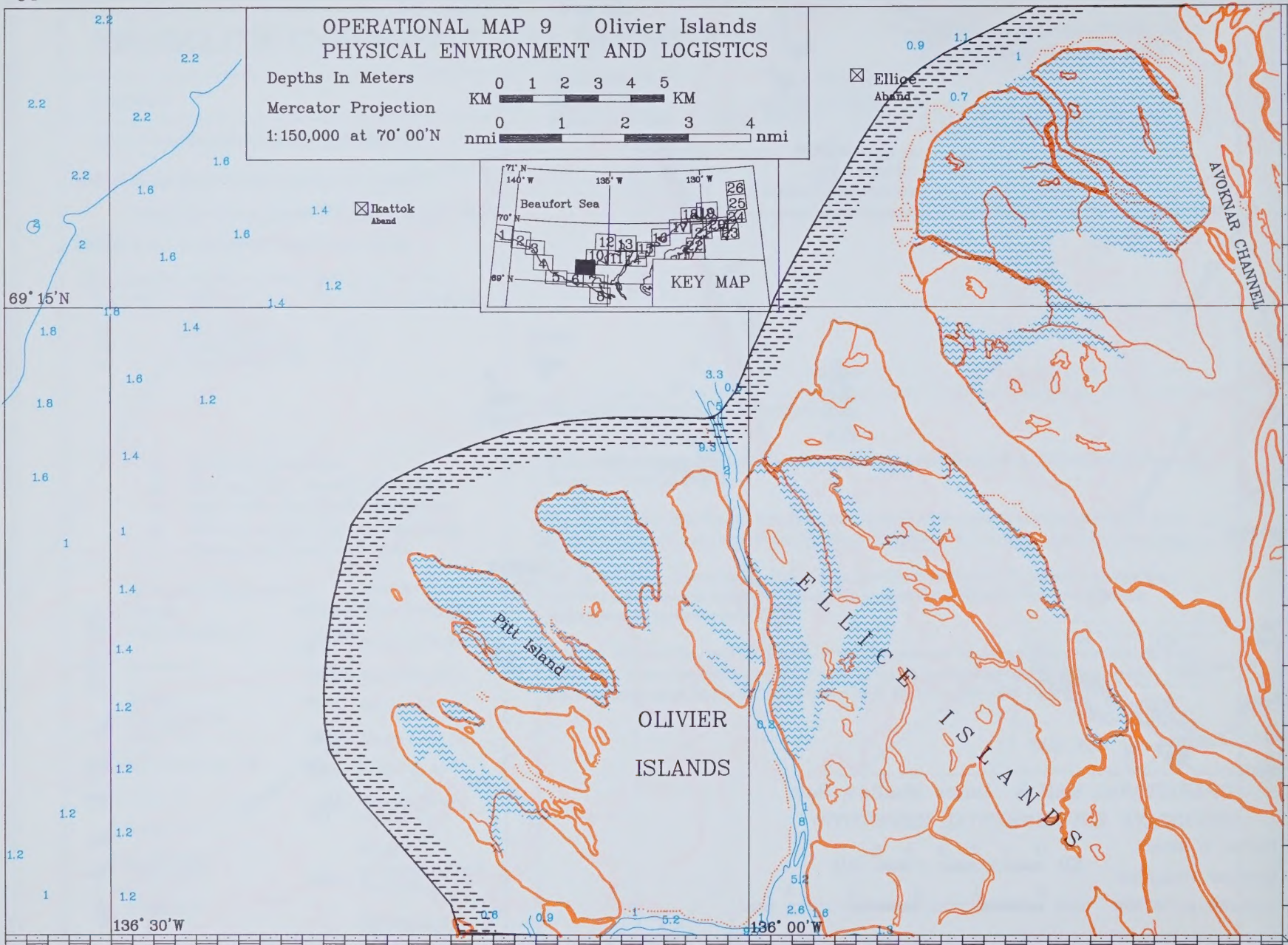
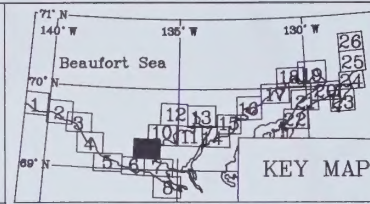
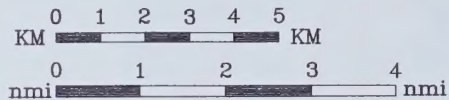


OPERATIONAL MAP 9 Olivier Islands PHYSICAL ENVIRONMENT AND LOGISTICS

Depths In Meters

Mercator Projection

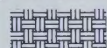
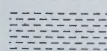
1:150,000 at 70° 00'N



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 9 OLIVIER ISLANDS

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7662

Video Tapes - Dome 8, 9, 10

Access:

Boat access in this region is nearly impossible due to the shallows fronting the mouth of the delta. Waters less than 1 m deep occur 15 km offshore. Deep water occurs in channels behind the river mouth, but access cannot be gained from offshore. Shore camps on the low lying delta are not recommended because of the dangers of storm surges. Any cleanup or protection team working on these low delta plains must have the capability of evacuating on very short notice during the open water season.

Safe anchorage at a depth of 1.8 m is available at the south end of Pelly Island, 50 km northeast. Anchorage near the spit at Pelly Island can be changed for protection from easterly or westerly winds.

Countermeasures:

Offshore countermeasures represent the only practical method of protecting the extensive delta shoreline. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

The extensive shoreline precludes the effective use of shoreline protection techniques. Deflector or diversion booms may be used to seal particular channels in order to limit the extent of contamination. The shallow coastal water depths may dictate the use of helicopters, rather than boats, to deploy equipment.

Heavy cleanup machinery must not be used on the sensitive delta shoreline. Small-scale manual cleanup methods may be used in areas of heavy contamination. As boat access is poor, helicopters may be required to support such cleanup activities.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 9 OLIVIER ISLANDS

Legend

Shoreline Environmental Sensitivity*

-  High Sensitivity Ranking > 68.70
-  Moderate Sensitivity Ranking 35.10 - 68.70
-  Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

21	Olivier Islands	52.75
22	Ellice Island	52.75

-  Archaeological Site
-  Heritage Site - locally identified
-  Major Resource Harvesting Camp
-  Other Resource Harvesting Camp
-  National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

 White Whale WW

 Bowhead Whale Bh

 Polar Bear PB

 Ringed Seal RS

 Bearded Seal BS

 Arctic Fox AF

 Reindeer Re or Caribou Ca

Fish

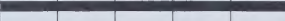
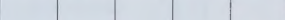
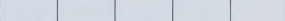
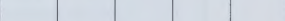
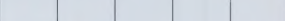
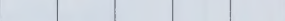
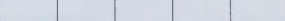
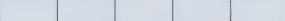
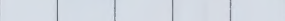
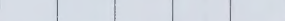
 Anadromous Fish & Pacific Herring F

 Site Specific

Occurrence of Species and Resource Use

Oil Exposed on Shoreline

R 21, 22
Ge 21, 22
F 21, 22

May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
											
											
											

Environmental Description:

R 21, 22 Ellice and Langley islands are used extensively by residents of Inuvik, Aklavik and Tuktoyaktuk for bird hunting from mid August to late September (11, 17). There are no camps on the islands, and hunting patterns change from year to year depending on weather conditions and distribution of the birds.

Ge 21, 22 From mid August to mid to late September, thousands of brant stage in coastal areas from the Olivier Islands and Ellice Island to the middle channel of the Mackenzie River and adjacent wetlands (3).

F 21, 22 Mackenzie River channels are important migration corridors for Arctic and least cisco and whitefish. These fish spawn and overwinter in the Mackenzie drainage and begin migration to coastal areas in May. Some fish may overwinter in the delta and in areas offshore of the delta where there is flow in channels beneath the ice. During summer, these species rear and feed in shallow coastal areas (1, 25).

OPERATIONAL MAP 9 Olivier Islands SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

Mercator Projection

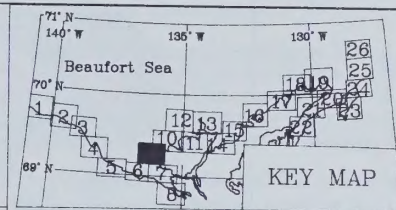
1:150,000 at 70° 00'N

0 1 2 3 4 5
KM

0 1 2 3 4
nmi

Ellice
Aband

Ikattok
Aband



69° 15'N

AREA 21

OLIVIER
ISLANDS

Pitt Island

Ge21

F21

AREA 22

Ge22

R22

F22

R21

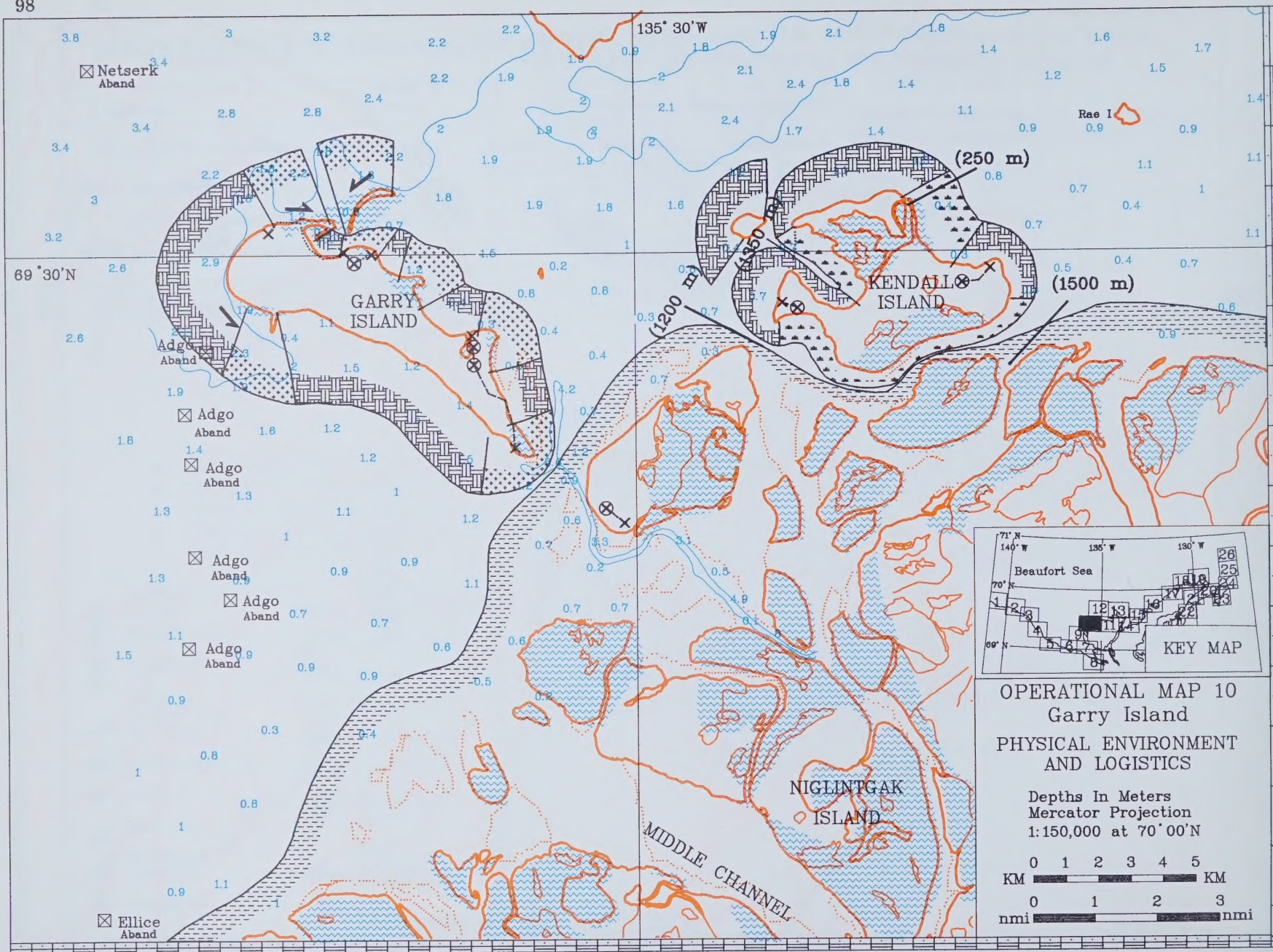
ELLICE
ISLANDS

ISLANDS

AVOKNAK CHANNEL

136° 30'W

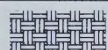
136° 00'W



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 10 GARRY ISLAND

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7662

Video Tapes - AGC 6, 7, Dome 9, 10, 11

Access:

The lee of Garry Island offers protected anchorage for vessels drawing up to 1.5 m, if winds are from the north or east. A normal tidal variation of 0.2 m is reported for Garry Island.

The coastal areas south of Garry Island are inaccessible by small boats. There is no access greater than 0.4 m in depth through the Middle Channel. Kendall Island can be approached by channels in the Mackenzie River. The channel south of Kendall is buoyed and provides access for vessels having a draft of less than 2.0 m. Distance from Kendall Island to Tuktoyaktuk via the Mackenzie River is 190 km. Extensive local knowledge is essential for navigation in the Mackenzie Delta.

The north shore of Kendall Island can be approached from the west by vessels drawing less than 1.4 m. Care must be taken when crossing the 1.5 km wide shoal (1.4 m of water) just north of Kendall Island. Small boats (0.5 m draft) cannot navigate close to the coastline southwest of Bird Island and east of Kendall Island because the water is too shallow. Access for small boats (drawing less than 0.5 m) through the 1,500 metre opening east of Kendall Island is difficult, especially on the mainland side. The water level is subject to rapid change under the influence of prevailing winds. Easterly winds lower water levels, while westerly winds raise the water level. Floatplanes can land on the west end of Kendall Island near the whaling stations. A 365 metre tundra airstrip, for emergency use, is located on Garry Island.

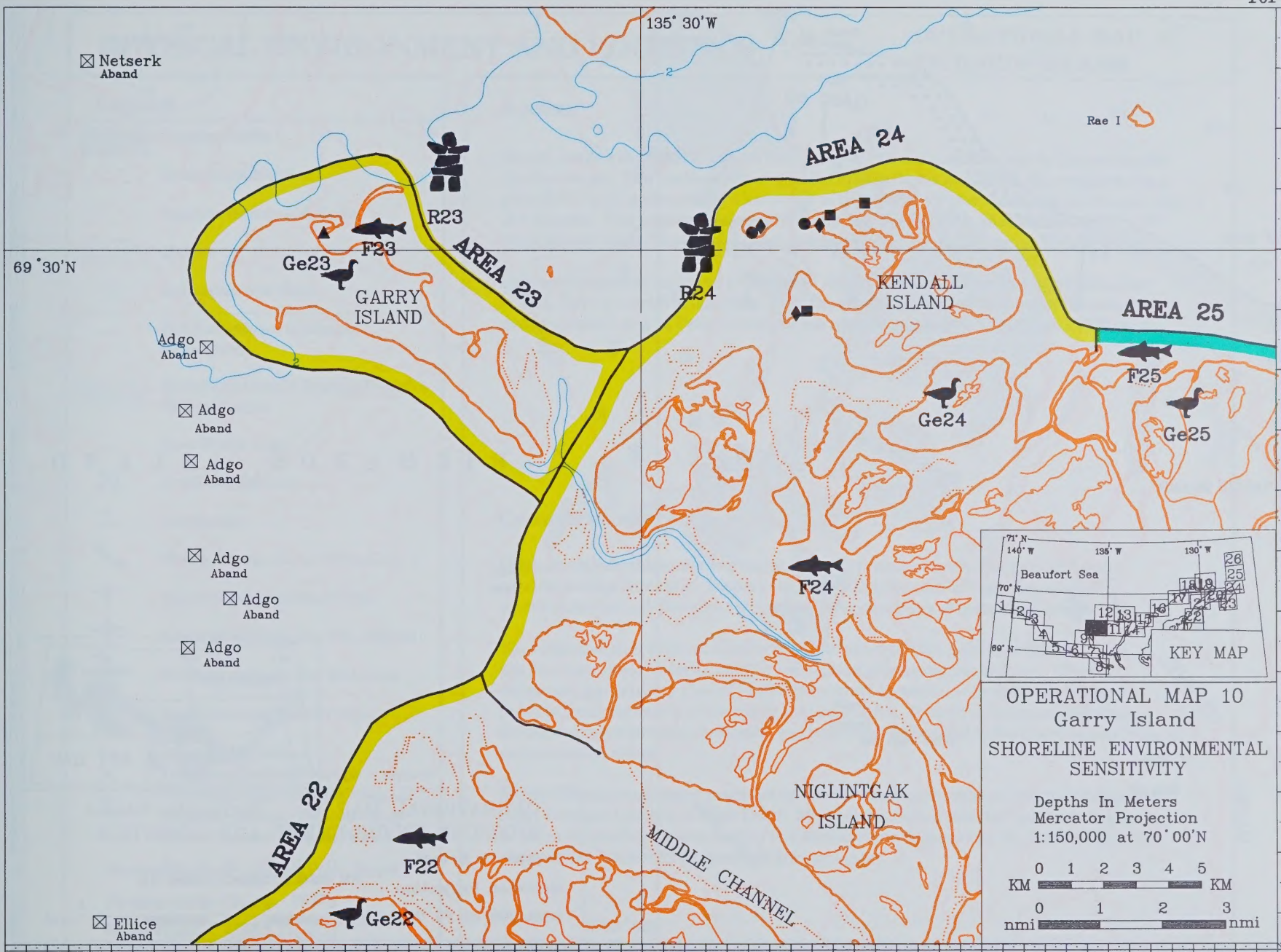
Sufficient shelter and anchorage exists in the Kendall Channel, lee of the small islands, for barge camps and vessels drawing less than 2 m. Currents vary according to local weather conditions and seasons, but are estimated at about 2 knots.

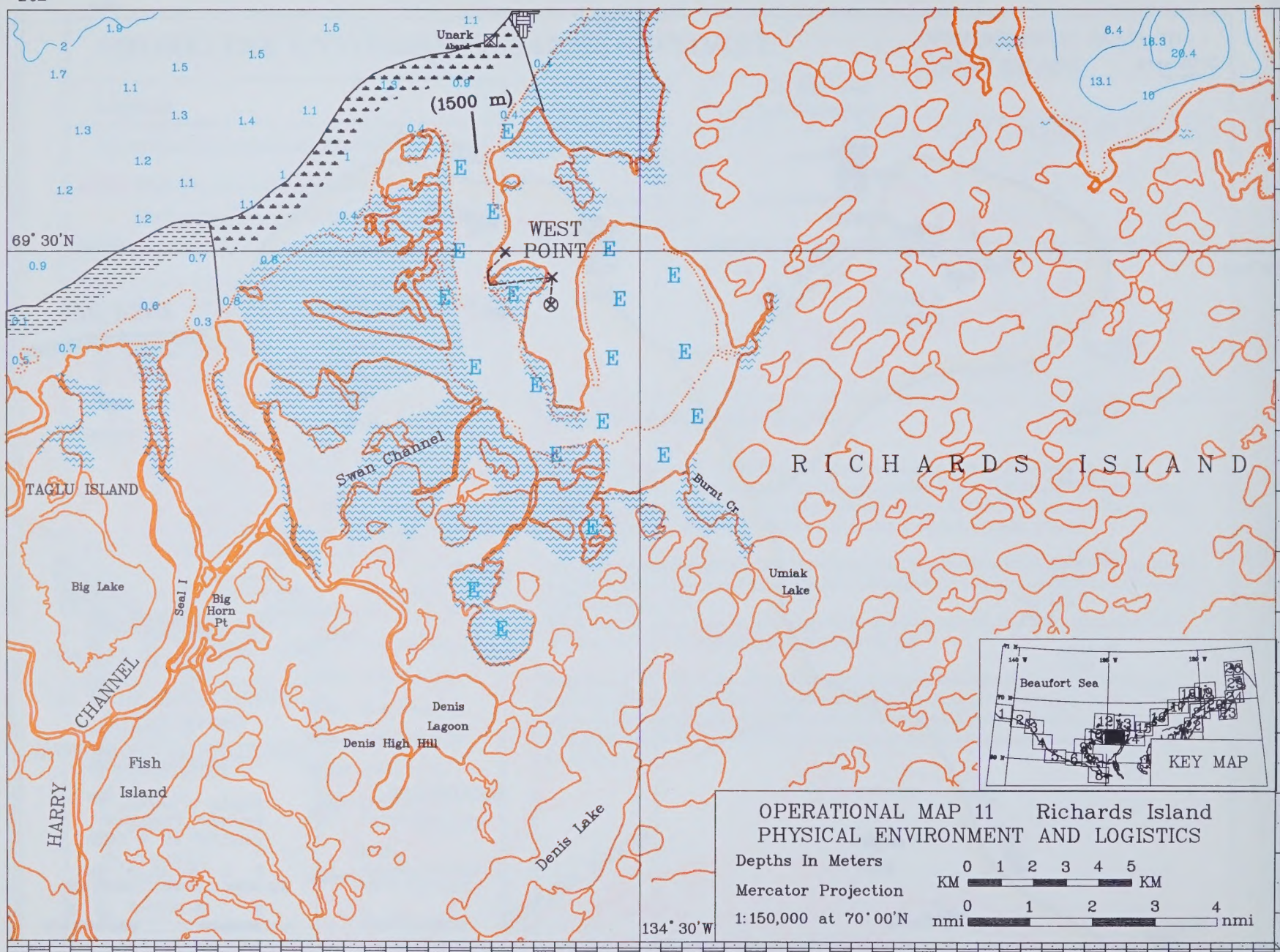
Countermeasures:

Offshore countermeasures represent the only practical method of protecting the extensive delta shoreline. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

The extensive shoreline precludes total protection of sensitive areas. In order to limit the extent of contamination, incoming slicks may be diverted to collection points on Pelly Island (Map 12) and Garry and Bird Islands. As a minimum response, the channels between Garry, Bird and Kendall Islands could be sealed with deflector booms, thus limiting the extent of inshore contamination.

Heavy cleanup machinery may be used on the sand beaches of Garry, Bird, and Kendall Islands although shore access during summer is generally poor. Cleanup machinery must not be used on the tundra shorelines of the delta. Potential disposal sites on Garry Island may be accessed via ice road in winter.





PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 11 RICHARDS ISLAND

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Shingle Point, Map 5

Hydrographic Chart - 7662

Video Tapes - AGC 7, Dome 11

Access:

Small, shallow draft boats cannot navigate close to the coastline, due to the extremely shallow water. The northerly channel into Mallik Bay is navigable, for vessels having a draft of 1 m, to a distance of 4 km south of the mouth. Water is deepest on the east side of the channel. The western channel of Mallik Bay is extremely shallow and not navigable by boat. The coastal areas are dangerous during strong northwest winds.

Safe anchorage can be found in the north channel of Mallik Bay, but is restricted to vessels having a draft of less than 1 m. The closest protected anchorage for vessels drawing over 1 m is at Pelly Island, 29 km northwest, and Pullen Island 25 km north.

Countermeasures:

Offshore countermeasures represent the only practical method of protecting the extensive delta shoreline. Dispersant use within the coastal zone is ecologically warranted when oil threatens waterfowl concentrations or waterfowl habitats.

The extensive shoreline makes the selection of protection priorities difficult. The shallow nearshore waters limit the application of booming techniques. Channel entrances, particularly that of Mallik Bay, could be sealed with deflector booms in order to limit the extent of shoreline contamination. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Heavy cleanup machinery must not be used on tundra shorelines, but may be used to clean the sand beaches of West Point. Manual cleanup of selected tundra beaches may be carried out where warranted by the degree of contamination. A potential disposal site on West Point may be accessed during winter.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 11 RICHARDS ISLAND

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
25	Taglu Island	35.00
26	West Point	53.00
29	North Point	13.65
32	Mason Bay	59.20

- Archaeological Site
- Heritage Site - locally identified
- Major Resource Harvesting Camp
- Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting

Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

Reindeer Re or
Caribou Ca

Fish

Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

Reference of es and rce Use	Oil Exposed on Shoreline												
	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
Ge 25													
Ge 26													
Sw 26													
DD 26													
DL 32													
F 25,26, 32													
F 29													

Environmental Description:

Ge 25 From June to mid to late August, thousands of nesting, brood-rearing and staging geese congregate in the Garry Island-Kendall Island area (3, 26).

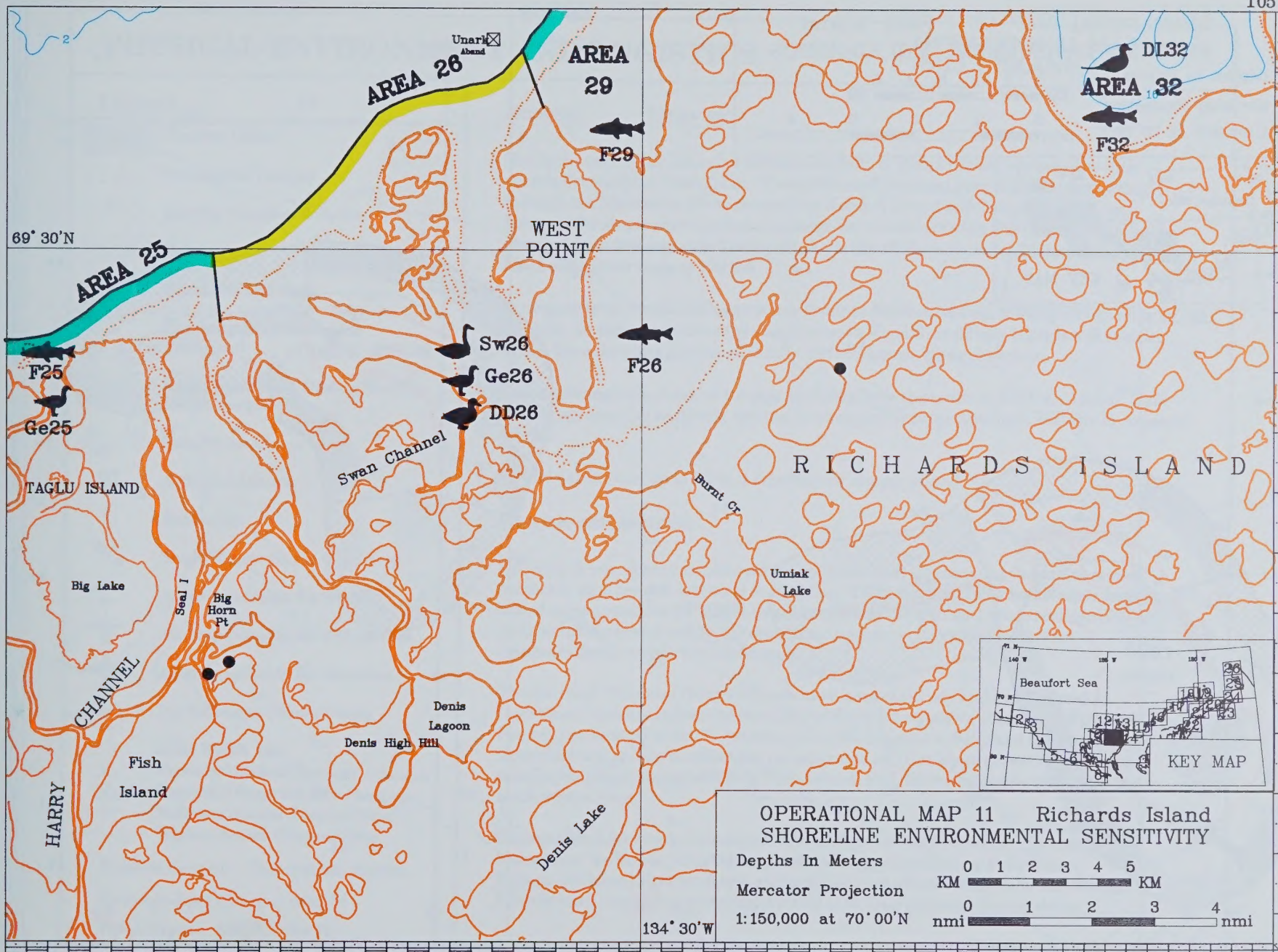
Ge 26, DD 26 From July through mid August, thousands of moulting and staging geese congregate in the Mallik Bay area and wetlands west of and immediately adjacent to Mallik Bay. From mid August to mid to late September, thousands of fall staging brant and dabbling ducks also congregate in these areas (3).

Sw 26 From June through mid August, hundreds of tundra swans nest, rear broods, and stage in the Mallik Bay area and wetlands west of and immediately adjacent to Mallik Bay.

DL 32 From early to late August, thousands of diving ducks congregate in Hansen Harbour, Mason Bay and Corral Bay to moult and feed (3).

F 25 Mackenzie River channels are important migration corridors for Arctic and least cisco and whitefish. Downstream migration to coastal areas may begin in May, and some fish overwinter in the delta and in areas offshore of the delta where there is flow in channels beneath the ice (1, 25).

F 26, 29, 32 Coastal areas provide important summer feeding and rearing habitat for anadromous and marine species (25, 28). Mallik Bay and Mason Bay are important overwintering areas for Arctic and least cisco, and several marine species including Pacific herring (2, 29). Pacific herring spawn in these bays (2).



OPERATIONAL MAP 12 Pelly Island PHYSICAL ENVIRONMENT AND LOGISTICS

Depths In Meters

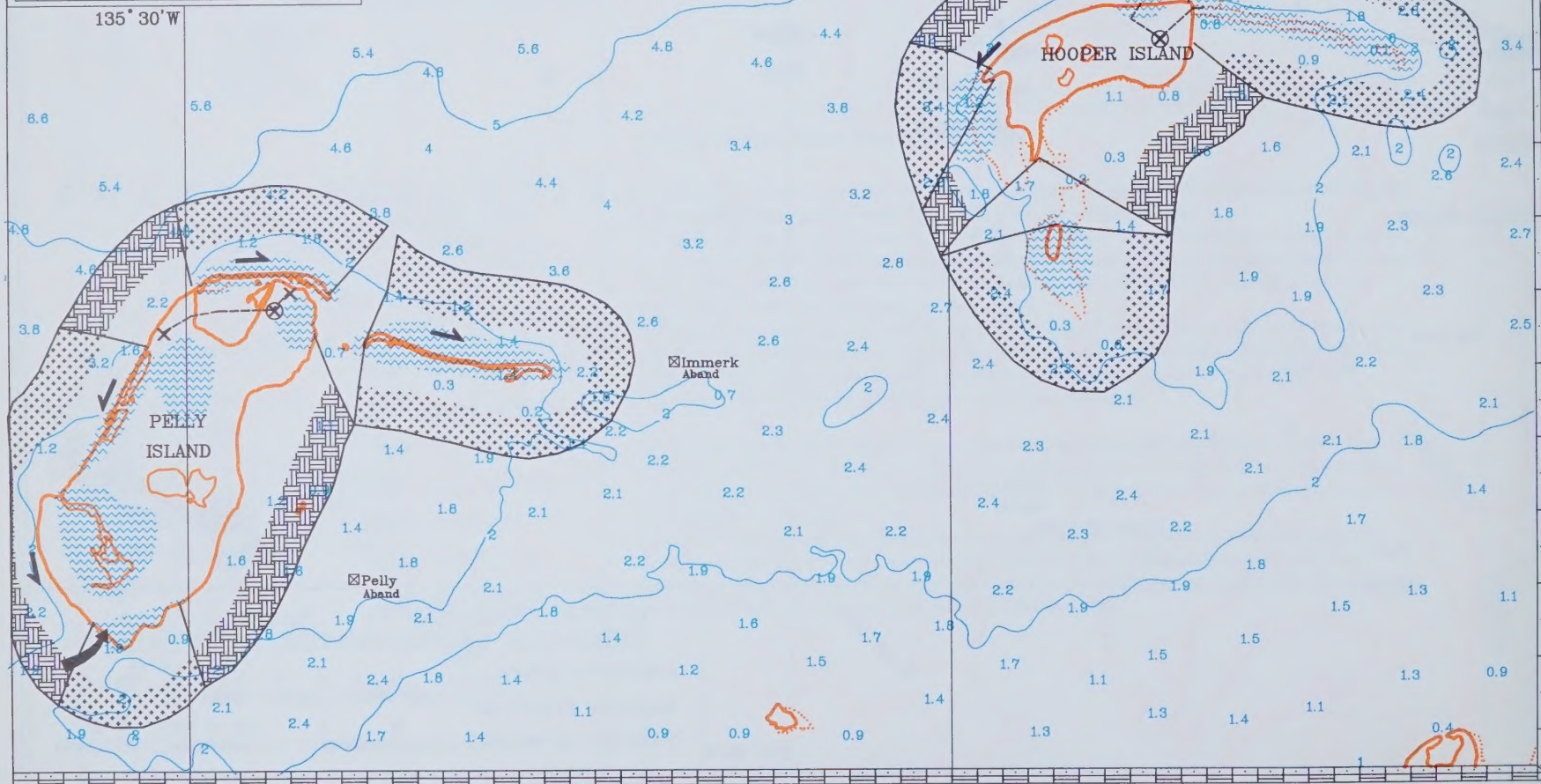
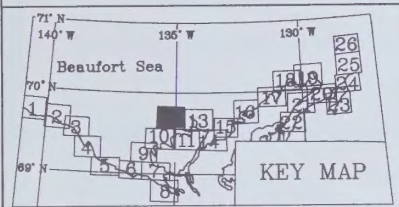
0 1 2 3 4 5

Mercator Projection

KM 0 1 2 3 4 KM

1:150,000 at 70° 00'N

nmi 0 1 2 3 4 nmi



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 12 PELLY ISLAND

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Tuktoyaktuk, Map 15

Hydrographic Chart - 7662

Video Tapes - AGC 7, Dome 10

Access:

Sheltered anchorage behind or access onto Pelly or Hooper Islands is possible with vessels drawing less than 1.2 m. If weather conditions are poor offshore, navigating through the Mackenzie River channels to Kendall Island and then out to Pelly and Hooper Islands provides sheltered passage for vessels drawing less than 1.4 m. The distance from this region to Tuktoyaktuk via the offshore route is 120 km; while via the Mackenzie River route is 190 km.

Strong easterly winds will lower water levels in Mackenzie Bay, making navigation difficult. In these conditions the shoal between Kendall and Pelly Islands will restrict access from the outer barrier islands to the Mackenzie River channels.

Safe anchorage at a depth of 1.8 m is available from the south end of Pelly Island. Safe anchorage near the southerly spit can be changed for protection from easterly or westerly winds.

A tidal variation of up to 0.3 m is reported for Hooper Island.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. The lee of both Pelly and Hooper Islands afford some protection for vessel-based operations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

The shores of Pelly and Hooper Islands have low sensitivity and may be used as "sacrificial" beaches to prevent the oiling of the more sensitive shorelines of the Delta. Booms may be used to divert incoming oil to the beaches of Pelly and Hooper, using skimmers and pumps to collect the concentrated oil. Use boom to seal both the spit opening on the northeast corner of Pelly Island, and, if necessary, the inlet near the southwest corner.

Cleanup machinery may be used on sand and gravel beaches subject to access limitations: an access point for barge offloading is identified on Pelly Island. Potential disposal sites for debris and sediment are identified on Pelly and Hooper Islands; each requires summer stockpiling with final disposal during winter.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 12 PELLY ISLAND

Legend

Shoreline Environmental Sensitivity*

-  High Sensitivity Ranking > 68.70
-  Moderate Sensitivity Ranking 35.10 - 68.70
-  Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

27	Pelly Island	15.00
28	Hooper Island	15.30

-  Archaeological Site
-  Heritage Site - locally identified
-  Major Resource Harvesting Camp
-  Other Resource Harvesting Camp
-  National or Territorial Park

Resource Harvesting Areas

 Highly Important R

 Important R

Birds

 Diving Ducks & Loons DL

 Dabbling Ducks DD

 Geese Ge

 Swans Sw

 Shorebirds & Cranes SC

 Seabirds Se

Mammals

 White Whale WW

 Bowhead Whale Bh

 Polar Bear PB

 Ringed Seal RS

 Bearded Seal BS

 Arctic Fox AF

 Reindeer Re or Caribou Ca

Fish

 Anadromous Fish & Pacific Herring F

 Site Specific

Occurrence of Species and Resource Use

F 27, 28

Oil Exposed on Shoreline											
May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr

Environmental Description:

F 27, 28 Nearshore areas adjacent to Pelly and Hooper islands, particularly in the lee of spits, provide important summer feeding habitat for a large number of marine and anadromous species (25, 30). Arctic and least cisco are abundant in these areas and use these areas for rearing (2, 25, 28).

OPERATIONAL MAP 12 Pelly Island
SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

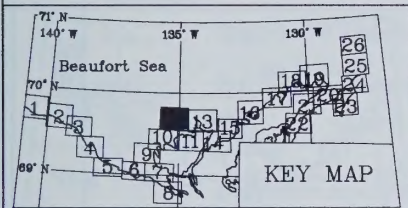
0 1 2 3 4 5

Mercator Projection

KM 0 1 2 3 4 KM

1:150,000 at 70° 00'N

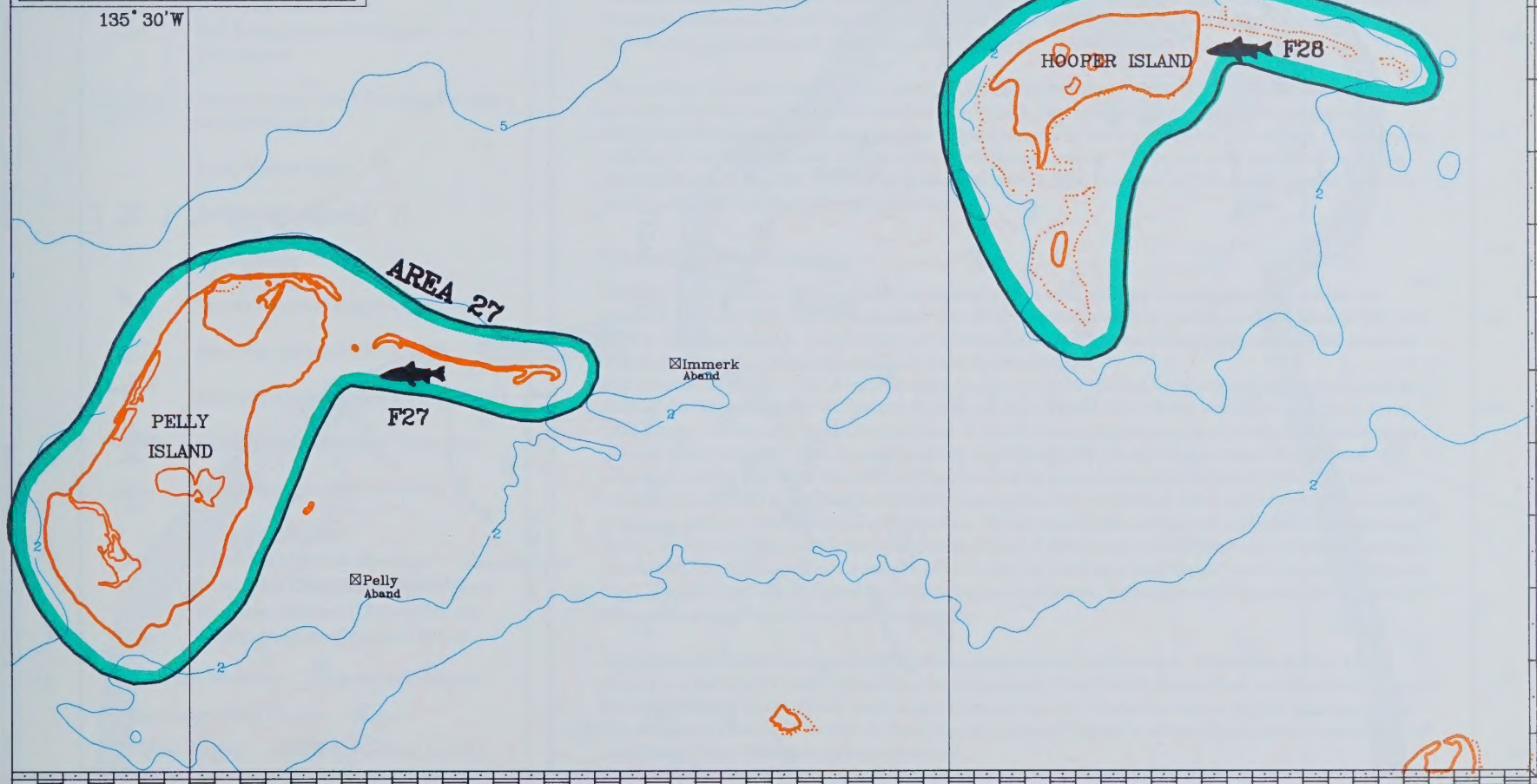
nmi 0 1 2 3 4 nmi



135° 30' W

135° 00' W

69° 45' N



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 13 NORTH POINT

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
E	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
()	Inlet Width (m)
X	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Tuktoyaktuk, Map 15

Hydrographic Chart - 7662

Video Tapes - AGC 5, 6, 7, Dome 11, 12

Access:

Access between Pullen Island and North Point is difficult for vessels drawing more than 1.8 m. Instead of trying to navigate through these shallow waters, time is saved by going around the north end of Pullen Island. The south tip of Pullen Island provides temporary shelter from northerly winds at a depth of 2 m.

Shallow draft barges can be beached near the cliffs at North Point and at the west end of the Reindeer Islands.

Access to Hansen Harbour is restricted to vessels drawing less than 1.2 m. Keep at least 1 km away from the northeast spit at Hansen Harbour as water depths are less than 0.5 m. A channel (1.2 m deep) into Hansen Harbour exists 0.5 km north from the small island.

Mason Bay has safe, protected anchorage for vessels drawing less than 2 m. The east entrance (between Hadwen and Summer Island) into Mason Bay is much deeper than the western one. Entrance through the eastern side is restricted to vessels having a draft of 2 m or less. The deepest channel is very narrow and occurs closest to Summer Island. There are wide mud flats on either side of the inlet. Depths at the entrance are reported to be in excess of 2 m, being greater than the depths recorded on the hydrographic chart.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Safe havens for vessel-based operations include Mason Bay and the lee of Pullen Island. Dispersant use within the coastal zone is ecologically warranted when oil threatens waterfowl concentrations or waterfowl habitats.

The beaches of Pullen Island may be used as concentration points for incoming slicks; however, as most of the island may be inundated during a storm surge, this is likely available as a short-term option only. Oil approaching the west side of North Point may be diverted to collection points near the identified temporary stockpiles; seal the entrance to the breached lake near North Head. Oil approaching the Reindeer Islands may be diverted to its sand beaches, although the mud flats fronting the islands make access difficult; openings to the northwest of the islands should be sealed, diverting slicks to less sensitive cliff beaches. To the southeast, entrances to Hansen Harbour and Mason Bay should be sealed, using deflector booms if shoreward winds produce currents in excess of 1 knot. The cliff beach at Crumbling Point may be used as a "sacrificial" beach to protect Mason Bay. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Only manual cleanup techniques should be used on tundra shorelines. Note that during storm surges, almost all of Pullen Island may be inundated. Potential disposal sites are identified at and to the southwest of North Head; land access from temporary stockpiles can be gained during winter. The temporary stockpile at North Head can be accessed by barge, allowing its use for material transferred from locations to the southeast.

F 30, 32 The northeast coast of Richards Island and Mason Bay are important overwintering habitat for cisco and Pacific herring, as well as other marine and anadromous species (2, 29). Pacific herring also spawn in these areas (2).

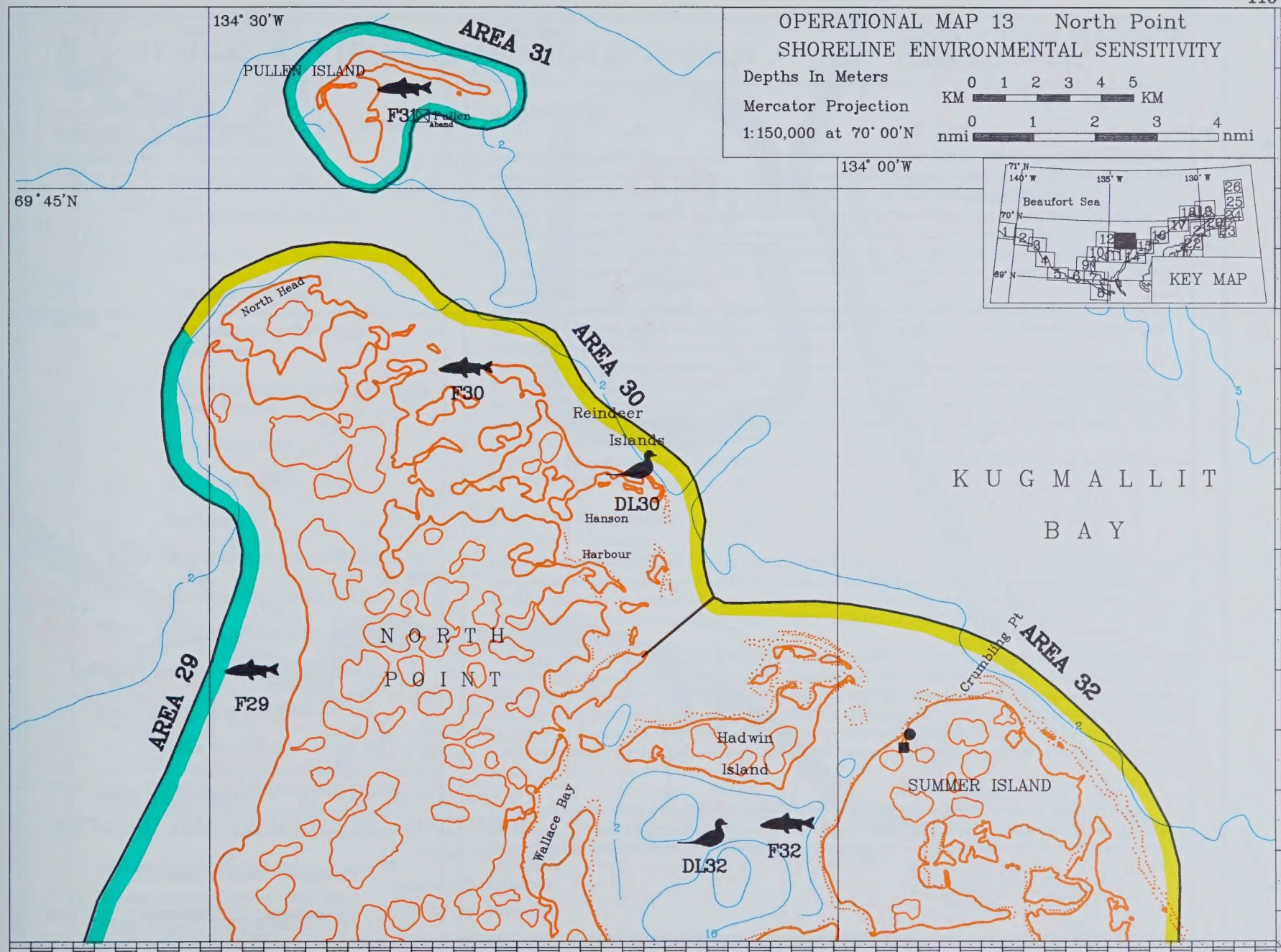
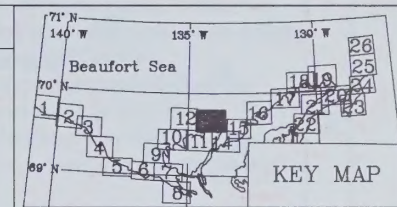
OPERATIONAL MAP 13 North Point SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

Mercator Projection

1:150,000 at 70° 00'N

 0 1 2 3 4 5
 KM

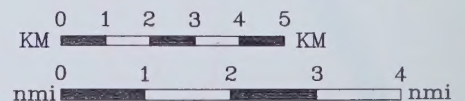
 0 1 2 3 4
 nmi


OPERATIONAL MAP 14 Kugmallit Bay
OPERATIONAL ENVIRONMENT AND LOGISTICS

Depths In Meters

Mercator Projection

1:150,000 at 70° 00'N



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 14 KUGMALLIT BAY

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Tuktoyaktuk, Map 15

Hydrographic Chart - 7662, 7663

Video Tapes - AGC 5, Dome 11, 12, 13, 28

Access:

Depths in Kugmallit Bay are shallow, not exceeding 4 m within 6.5 km of the shoreline. Wide variations can occur in ice break-up and freeze-up dates. Kugmallit Bay normally clears of ice during the first week of July, and freeze-up usually begins during the second week of October. Kidluit Bay provides shelter for small boats not drawing more than 0.9 m. Approach Kidluit Bay from the north end of Hendrickson Island and enter through the channel north of Gull Island. Depths at the mouth are 1 m whereas inside the bay depths are 1.5 m. With the exception of Kidluit Bay, it is impossible to approach within 1.5 km of the east shore of Richards Island, except in a canoe, as depths do not exceed 0.6 m.

A few kilometres inside the East Channel provides temporary safe anchorage during poor weather. The outer Kittigazuit Harbour, with an entrance of 180 m wide on the west side of the abandoned settlement, provides good shelter for craft with drafts up to 1.8 m.

Vessels drawing 2 m or less can get fairly close to Whitefish Station. There is a 0.5 m deep shoal fronting Whitefish Station inlet about 600 m offshore. Smaller power boats and shallow draft barges can manoeuvre around the shoal and be beached near the fishing and whaling station. A protected inland channel between Whitefish Station and Kittigazuit can be navigated by small boats. The limiting depth is 0.9 m.

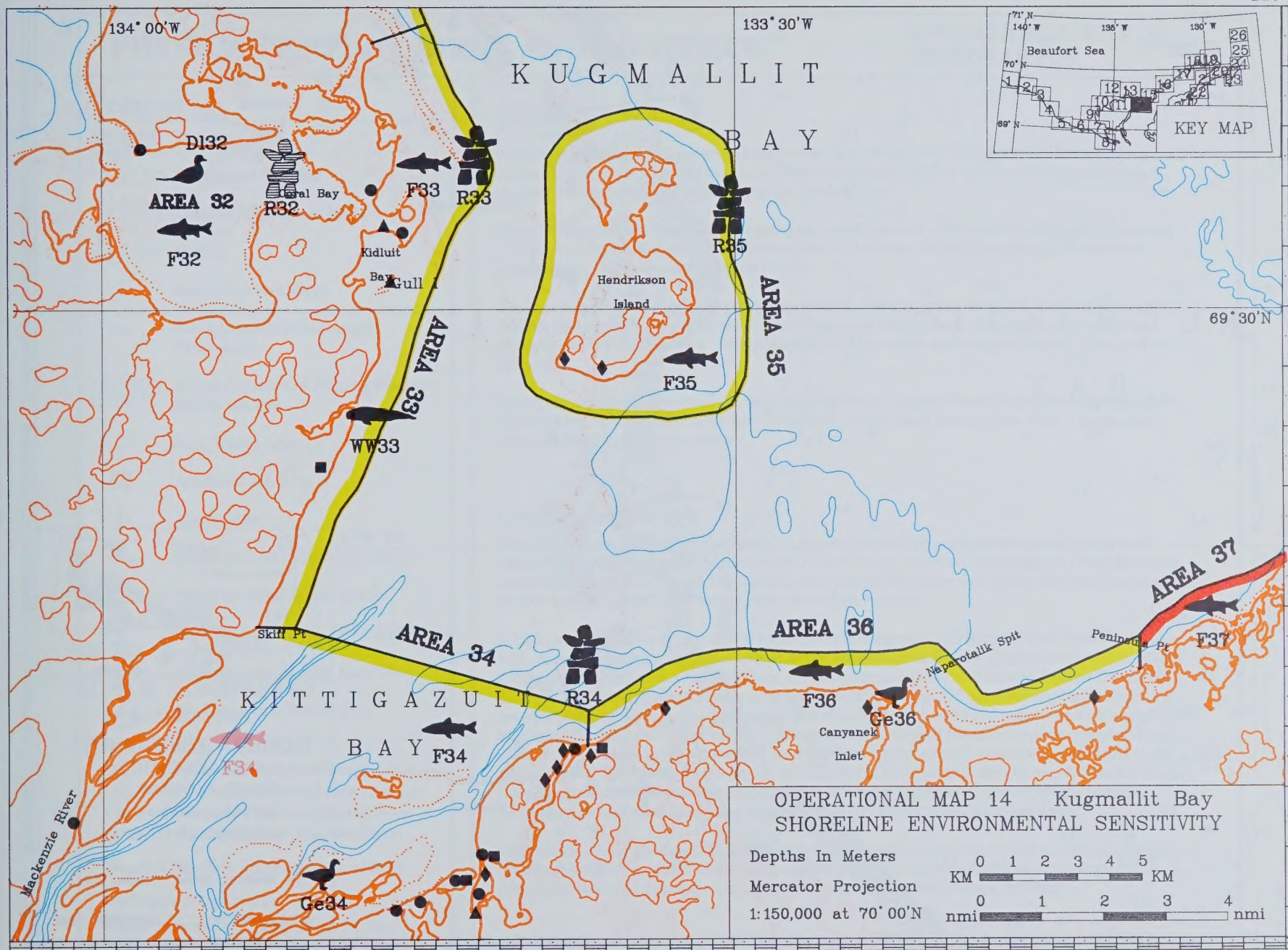
Canyanek Inlet is a small harbour with a narrow 100 m wide entrance. The limiting depth is 0.9 m at the entrance to the harbour.

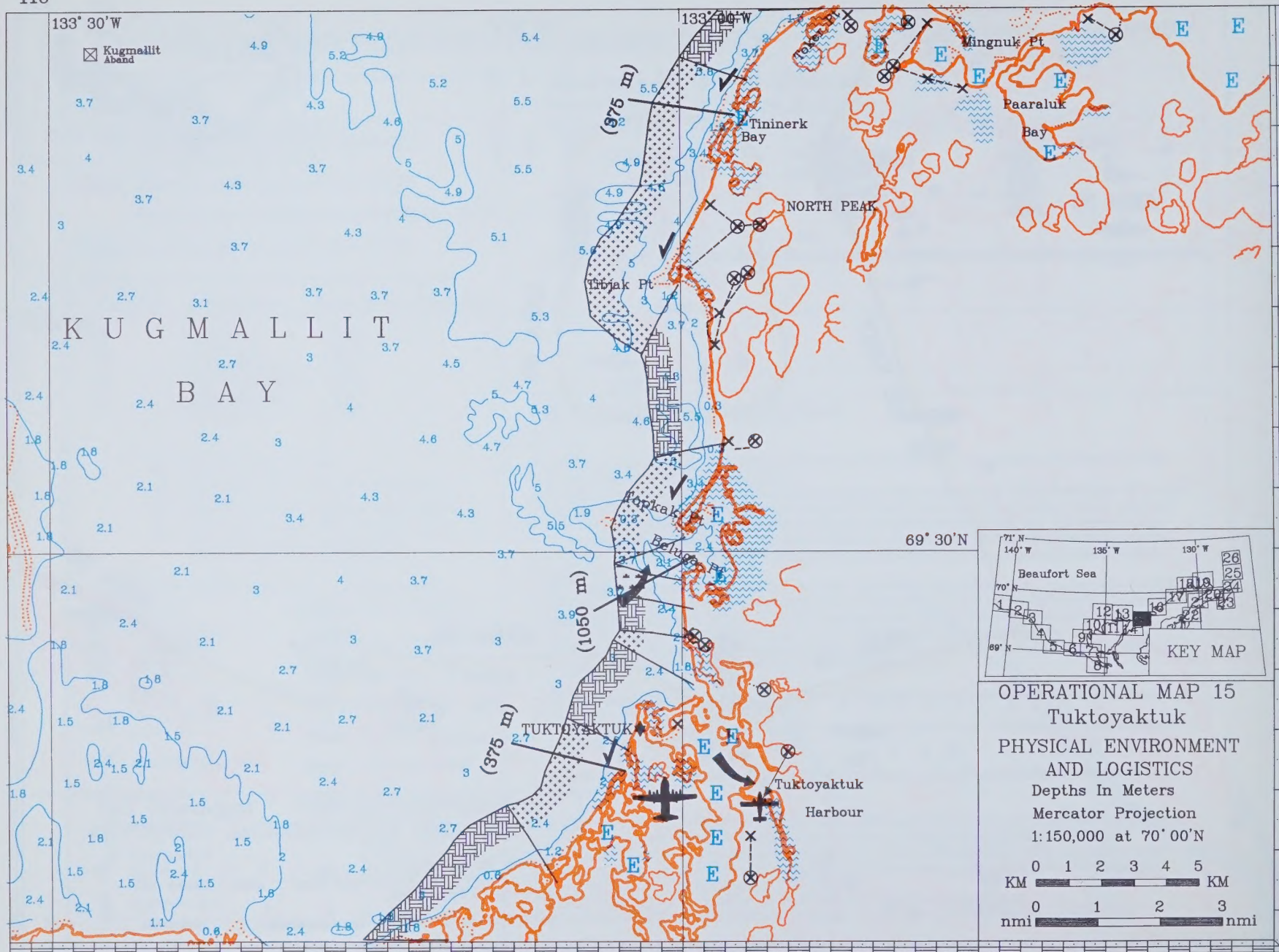
Countermeasures:

Offshore countermeasures are essential to protect the vast shorelines of Kugmallit Bay. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats. Note that the low salinity waters resulting from the Mackenzie River outflow may reduce the effectiveness of conventional dispersants.

A high priority should be given to protecting the seasonal camps at Kittigazuit and Whitefish Station. Seal the Kittigazuit lagoon, diverting oil to nearby cliff and sand beaches; high currents are common at the lagoon entrance. Limit the extent of inshore contamination by sealing the five inlets east of and including Canyanek Inlet: total inlet width is approximately 1700 m. Oil approaching Kidluit Bay may be diverted to the sand beaches on either approach. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Cleanup priority should be given to the sand and gravel beaches from Canyanek Inlet to, and including, Kittigazuit Bay. Potential disposal sites that are remote from the seasonal camps near Whitefish Station are preferred. Winter ice roads could be used to transfer stockpiled debris and sediment.

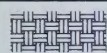




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 15 TUKTOYAKTUK

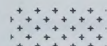
Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Tuktoyaktuk, Map 15

Hydrographic Chart - 7663

Video Tapes - AGC 4, 5, Dome 13, 14

Access:

Vessels drawing up to 4.2 m can find protection from all winds in Tuktoyaktuk Harbour (Map 15A). Under the influence of strong winds, extreme water levels of 2.3 m above and 0.8 m below chart datum have been recorded in Tuktoyaktuk Harbour.

When leaving Tuktoyaktuk Harbour going eastward, proceed northward with Ibyuk Hill bearing 170° 30' astern until the outermost fairway buoy is reached. At this time, change course east-northeast to pass northward of James Shoal.

The leeside of Topkak spit offers temporary shelter. Vessels with a draft of 1 m or less can enter Topkak Bay by navigating between Topkak Shoal and Beluga Reef. Topkak Shoal lies 1.5 km westerly and northerly from it. Beluga Reef lies 2.8 km south-southeast of Topkak Shoal and 460 m offshore.

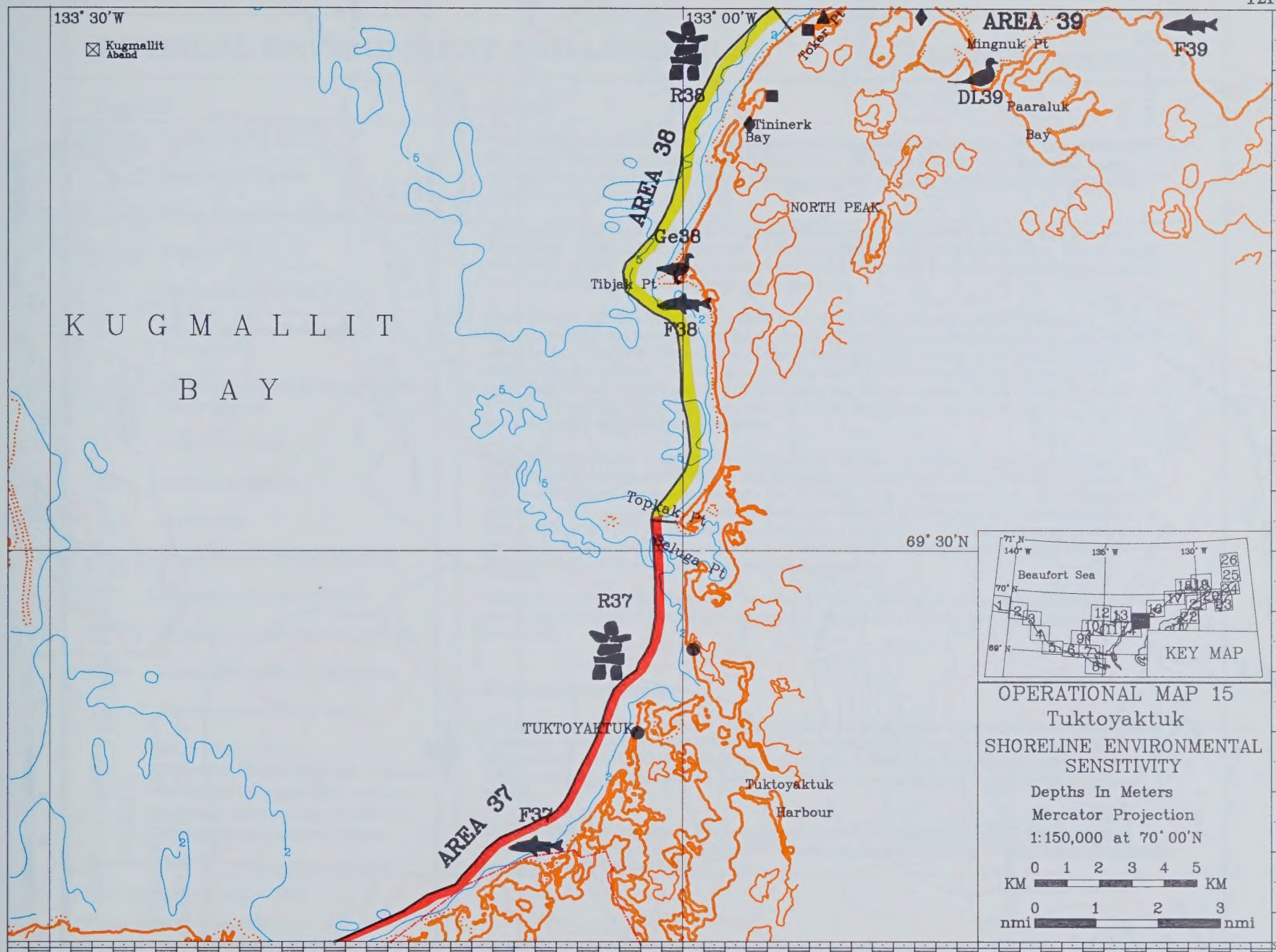
Strong currents/tidal streams have been experienced off Topkak Shoal, in the close approaches to Tuktoyaktuk Harbour, and in Eastern Entrance. Small boats drawing less than 1 m can enter Tininerk Bay for temporary shelter.

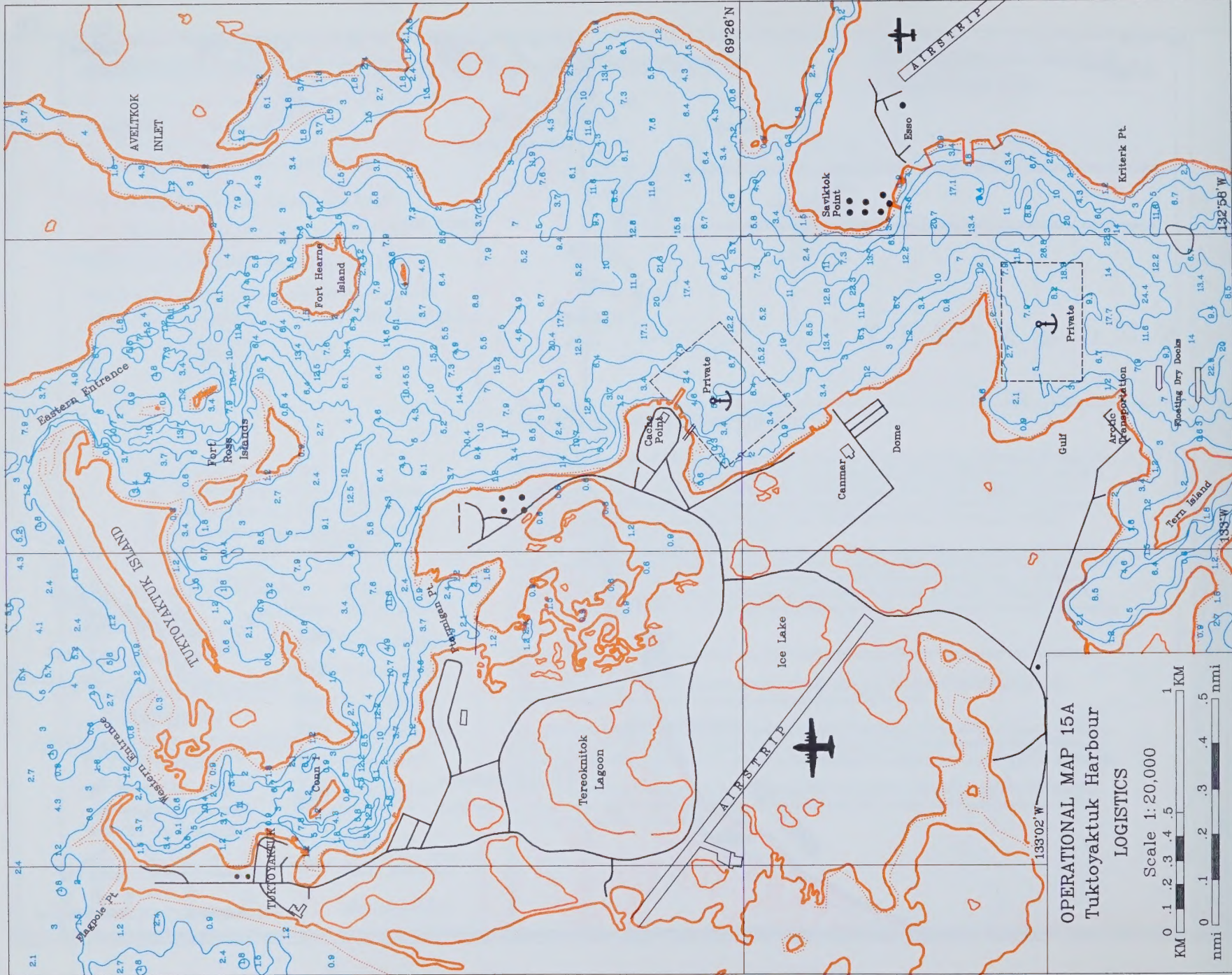
Countermeasures:

Offshore countermeasures are essential to protecting the highly important coastal areas near Tuktoyaktuk. Tuktoyaktuk Harbour (Map 15A) offers an excellent anchorage and base for vessel-based operations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

A high protection priority is to seal the entrances to Tuktoyaktuk Harbour; tidal currents may be high, naturally protecting the harbour at times, necessitating the use of deflector booms at others. Oil may be diverted to the exposed shore of Tuktoyaktuk Island. The bays at Topkak Point and Tininerk Bay are of moderate sensitivity and should be sealed. Oil approaching the shoreline in between these two areas may be concentrated with deflector booms and recovered with pumps and skimmers. The relatively low energy environment of Kugmallit Bay should allow effective cleanup operations. Beaches in the area afford good seaward access, as well as access to stockpiles and disposal sites. If threatened, the lagoon inlets south of Tuktoyaktuk may be sealed in order to limit the extent of inshore contamination. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

The coastline from Tuktoyaktuk to Mingnuk Point is used extensively by regional residents and certain areas are important bird staging areas: cleanup priorities should be set accordingly. Numerous potential disposal sites with good access are identified along the coast.

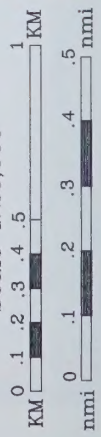




OPERATIONAL MAP 15A
Tuktoyaktuk Harbour

LOGISTICS

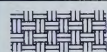
Scale 1:20,000



PHYSICAL ENVIRONMENT AND LOGISTICS

15A TUKTOYAKTUK HARBOUR

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Tuktoyaktuk, Map 15

Hydrographic Chart - 7685

Video Tapes - Dome 13

Access:

Vessels with drafts up to 4.2 m can find protection from all winds inside Tuktoyaktuk Harbour. There is a tidal range of up to 0.5 m. Prolonged westerly winds may raise water levels by up to 2.7 m (1962) while prolonged easterly winds may reduce normal water levels by up to 1 m (1963).

Access into Tuktoyaktuk is by two narrow channels; Western Entrance and Eastern Entrance. The Eastern Entrance is the principal entrance to the harbour. The channel is buoyed, with a controlling depth of 4.4 m (1978). Shallow draft tugs and barges can be beached along the gravel shorelines at the inlet.

Only vessels piloted by someone with local knowledge should use the Western Entrance. The narrow channel has a depth of 3 m, but is encumbered by shoals. One shoal awash lies 280 m northeast of the gravel spit and another also awash lies 107 m east of the gravel spit. 2.1 to 2.4 m of water can be found close along the spit. This approach should be favoured when entering the western inlet. Once inside, a vessel should keep a middle channel course. Shallow draft boats can dry ramp along the gravel beaches at Western Entrance.

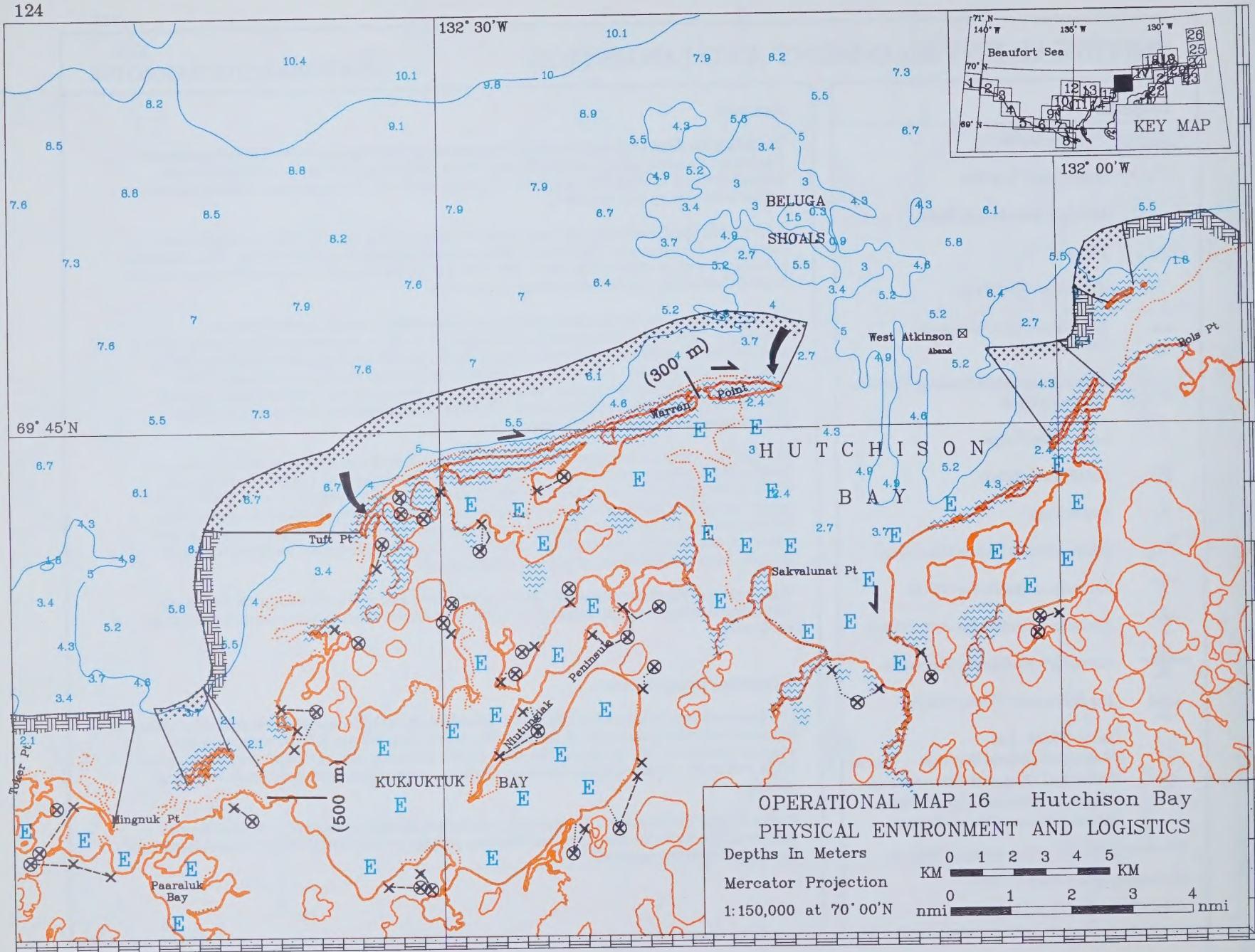
Most of the western beaches of Tuktoyaktuk Harbour are near roads. Floatplanes can land in the harbour, generally in the area immediately west of Tuktoyaktuk Island; docking facilities are available near the Hudson's Bay Company Store. A 1,600 metre gravel airstrip suitable for year-round use is situated 0.5 km south of the community. A 640 metre gravel airstrip is located at the Esso base camp. Several privately operated wharves are found in Tuktoyaktuk Harbour, along with prepared landing ramps for barges, haul-out facilities, and fresh water supplies.

Tuktoyaktuk Harbour normally clears of ice in the last week of June, with freeze-up occurring during the first week of October. Variations of up to two weeks can occur in each case.

Countermeasures:

Oil approaching Tuktoyaktuk Harbour should be diverted to accessible beaches on either approach or onto Tuktoyaktuk Island. The western entrance (150 m wide) and the eastern entrance (260 m) should be sealed with deflector booms. Tidal currents may be high, naturally protecting the harbour at times, necessitating steeper boom angles at others.

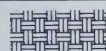
Spills within Tuktoyaktuk Harbour should be contained for recovery. The protected waters of the harbour should allow effective recovery operations. Dispersants should not be used within the harbour.



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 16 HUTCHISON BAY

Legend



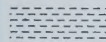
Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Tuktoyaktuk, Map 15

Hydrographic Chart - 7663

Video Tapes - AGC 5, Dome 14, 15

Access:

Close inshore, many long sand banks have formed parallel to the coast, particularly east of Hutchison Bay. Depths are continually changing due to the effects of erosion and sediment deposition. The 9.1 metre contour parallels the coast at a distance of 13 km.

Access into Kukjuktuk (Parlaiyut) Bay is through the 450 metre wide inlet and is restricted to vessels drawing less than 1.5 m. Safe anchor is found at Tuft Point in over 4 m of water.

Offshore depths are sufficient to allow beaching shallow draft barges on the ocean side of Warren spit. Beluga Shoals stretch 9 km north and about 7 km east-northeast of Warren Point. The least depth is 0.3 m, lying 6.0 km northeast of Warren Point. A depth of 0.9 m is situated 1.2 km southeast of 0.3 metre shoal spot. Two 2.4 metre shoal heads lie 4 km north and 7 km north-northeastward of Warren Point. Breakers indicate the easterly limit of Beluga shoals. The barrier beach between Tuft Point and Warren Point is reported to be breached 3 km east of Tuft Point. Inlet depth is reported to be up to 1.5 m.

Warren Point spit creates a lagoon that offers temporary shelter from northerly and easterly winds. This lagoon has depths from 2.1 to 2.7 m and has safely harboured small boats in hurricane winds. Fresh water is available from nearby lakes.

Countermeasures:

Offshore or nearshore containment for recovery or in-situ burning is recommended subject to weather and logistical limitations. Safe haven for vessel-based operations is available in Hutchison Bay or behind Tuft Point. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

High protection priorities are Hutchison and Kukjuktuk Bays, their tundra shorelines and the several breached lakes: incoming oil may be diverted to the sand beaches of Warren Point for collections with pumps and skimmers. Threatened breached lakes should be sealed, particularly Kukjuktuk Bay which may require deflector booms due to the strong currents at its entrance. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Barge access to several points between Tuft and Warren Points may be used to deliver cleanup machinery (note the zone of possible storm surge inundation). Numerous potential stockpile and disposal sites are identified.

Shoreline Environmental Sensitivity*

High Sensitivity Ranking > 68.70

Moderate Sensitivity Ranking 35.10 - 68.70

Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
----------	-----------	---------------------

39	Kukjuktuk Bay	59.15
40	Tuft Point	32.50
41	Hutchison Bay	65.90
42	Drift Point	38.63

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

- White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

Reindeer Re or
Caribou Ca

Fish

Anadromous Fish &
Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

R 39, 40, 41

DL 39, 41

F 39

F 40, 41, 42

Oil Exposed on Shoreline

May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr

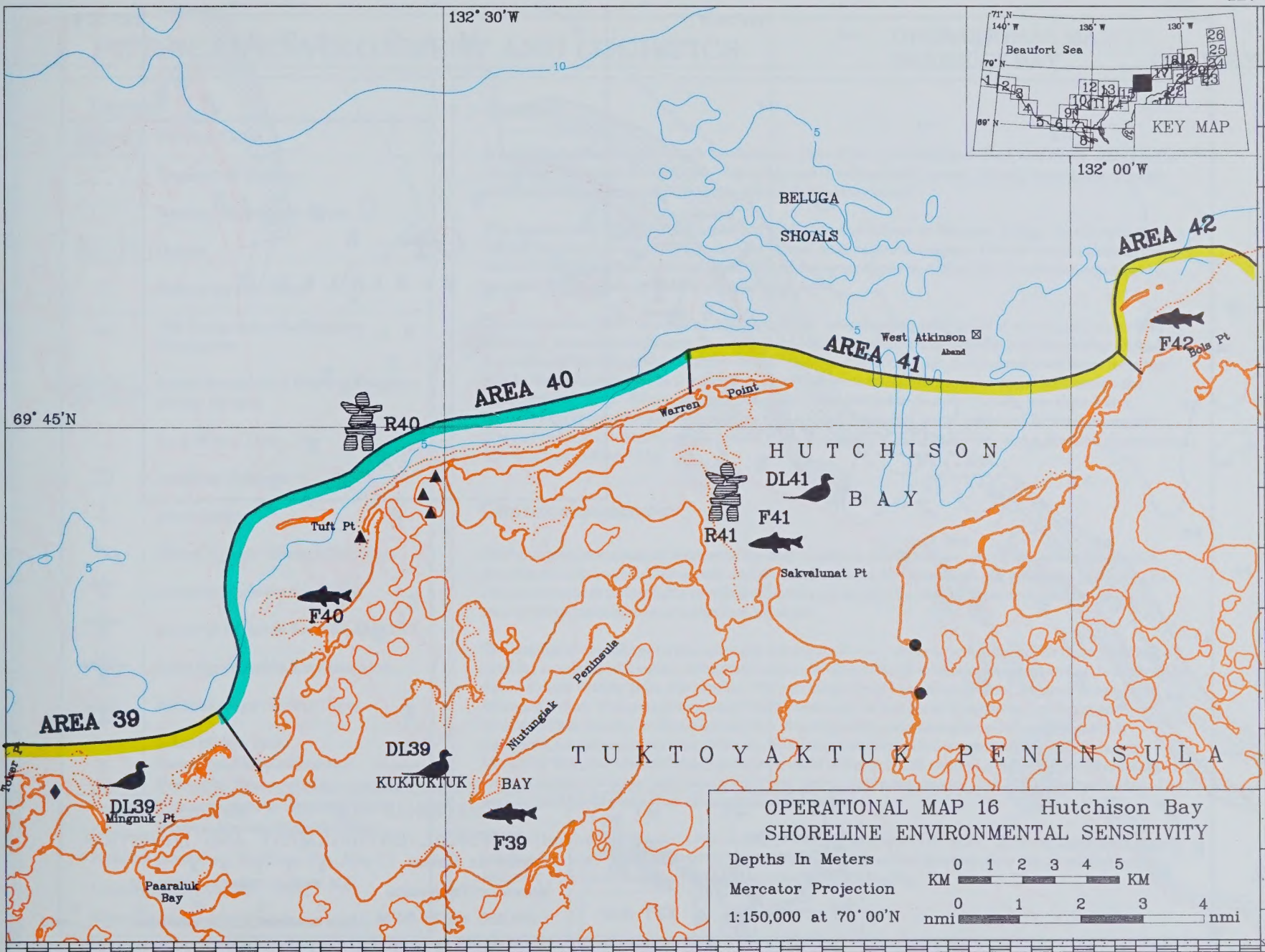
Environmental Description:

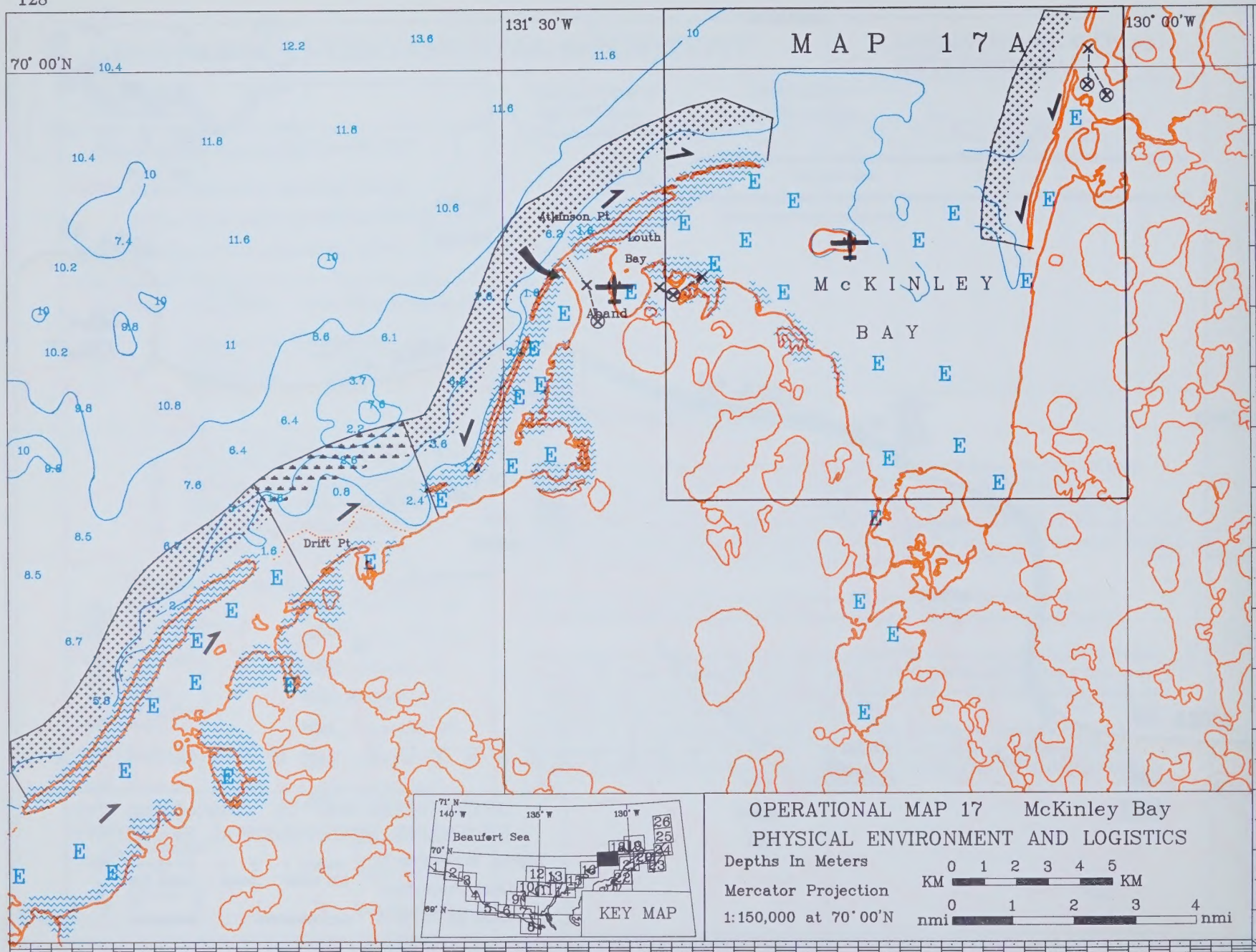
R 39, 40, 41 The offshore area from Toker Point to Hutchison Bay is used to hunt seals and polar bears from September to freeze-up and from January to the end of May, respectively. Hutchison Bay is also an important area for harvesting seals in summer. A limited number of whales are taken off Tuft Point in late August. Camps are often located at Tuft Point and along the sheltered northwest part of Hutchison Bay in the summer. Spring and fall goose hunting also occurs along this section of coastline (17, 20).

DL 39, 41 From mid July to mid September, thousands of diving ducks moult in Kukjuktuk and Hutchison bays and adjacent protected embayments and lagoons (3).

F 39 Kukjuktuk Bay provides overwintering habitat for Arctic and least cisco and Pacific herring (2). Pacific herring are thought to spawn in Kukjuktuk and Hutchison bays in the spring (2). In mid summer, large numbers of broad whitefish, lake whitefish and least cisco migrate to rivers that drain into Kukjuktuk Bay (2).

F 39, 40, 41, 42 Hutchison Bay, Kukjuktuk Bay and the adjacent coastline areas are important migration corridors for whitefish and cisco during spring, summer and fall. During summer, marine and anadromous species use coastal areas for feeding and rearing (28).

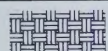




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 17 McKINLEY BAY

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas



Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - McKinley Bay, Map 17

Hydrographic Chart - 7663

Video Tapes - AGC 3, 4, Dome 15, 16, 27

Access:

A recently formed barrier beach lies between Drift Point and Hutchison Bay, and limits access to the shoreline. Its shape is constantly changing, and it is frequently awash. It may be possible to beach shallow draft barges along the ocean side of this barrier beach.

The lagoons east of Drift Point are much shallower than those at Atkinson Point. Small boats can get behind the sand spit east of Atkinson Point, but have restricted access. Deeper water exists directly behind the spits, but shoals less than 0.5 m deep occur closer to shore. Shallow draft barges can be beached along the ocean side of exposed sand spits.

The abandoned DEW line site at Atkinson Point has a landing pier, 1,066 m airstrip, oil tanks and buildings that are conspicuous from seaward. A short landing pier projects into Louth Bay about 500 m northeastward from the oil tanks on the western side of the bay. A prepared road leads from the pier to the buildings and to the airstrip. Fresh water is available from the small lake beside the abandoned airstrip. Access to the landing pier is restricted to vessels drawing less than 1.8 m. The passage is crooked and very narrow and a shoal lies about 180 m eastward of the landing pier. The normal tidal variation at Atkinson Point is up to 0.5 m. McKinley Bay has a dredged channel and mooring basin (Map 17A).

Countermeasures:

Offshore countermeasures represent the only practical method of protecting the extensive tundra shorelines in this area. Safe haven and an excellent base for operations are located in McKinley Bay. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

The extensive shorelines in this area are not amenable to complete protection. The most practical strategy is to limit the extent of contamination by diverting oil to barrier beaches and spits that can be cleaned more readily than the tundra. This strategy could be used to protect the area around Atkinson Point. The coastline west of Drift Point may be temporarily protected by the recently formed barrier beach. In this case, as with diverting oil to exposed spits, oil should be quickly recovered, as storm surges may drive the oil to shore and inland at some locations. If oil enters McKinley Bay, the several breached lakes should be sealed with booms in order to limit the extent of contamination. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Exposed barrier beaches and spits should be cleaned in a timely manner. Cleanup machinery may be delivered by shallow draft barge at several locations. Potential disposal sites are identified near Atkinson Point and near the eastern entrance to McKinley Bay.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 17 McKINLEY BAY

Legend

Shoreline Environmental Sensitivity*

-  High Sensitivity Ranking > 68.70
-  Moderate Sensitivity Ranking 35.10 - 68.70
-  Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
42	Drift Point	38.63
43	Atkinson Point	75.65
44	Crescent Bank	28.80

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

Reindeer Re or
Caribou Ca

Fish

Anadromous Fish &
Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

	Oil Exposed on Shoreline												
	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
R 43													
Ge 43													
DL 42, 43													
Re 43													
F 42													
F 43													

Environmental Description:

R 43 Atkinson Point is an important area for residents of Tuktoyaktuk in both summer and winter. A cabin is located on the point and is used throughout the year. There are also a number of archaeological sites and a heritage site of importance to regional residents in this area.

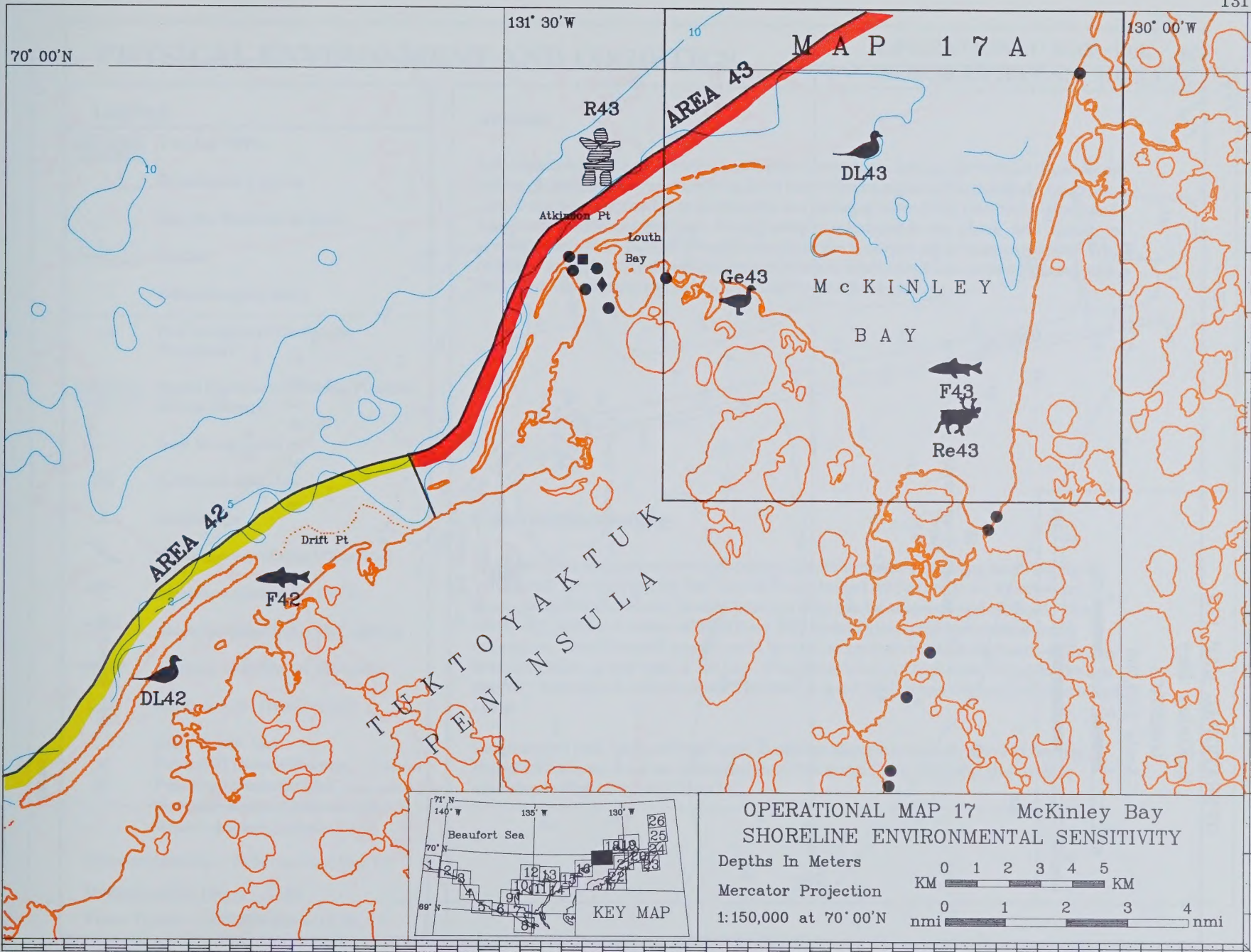
Ge 43 From June through mid August, hundreds to thousands of brant nest, rear broods, moult and stage in coastal areas west of McKinley Bay (3).

DL 42, 43 From mid July to mid to late August, thousands of diving ducks moult and stage in McKinley Bay and adjacent protected coastal waters (3).

Re 43 From late July through early September, the reindeer herd uses several nearshore areas of Tuktoyaktuk Peninsula to escape from flies during the height of the insect season (27).

F 42, 43 Nearshore areas provide summer feeding and rearing habitat for anadromous and marine species and are also important migration corridors for whitefish and cisco in the spring and fall (28).

F 43 McKinley Bay provides important habitat for broad whitefish in August, when a large number of juveniles migrate into freshwater drainages of the bay (28). Pacific herring spawn and overwinter in McKinley Bay (2).

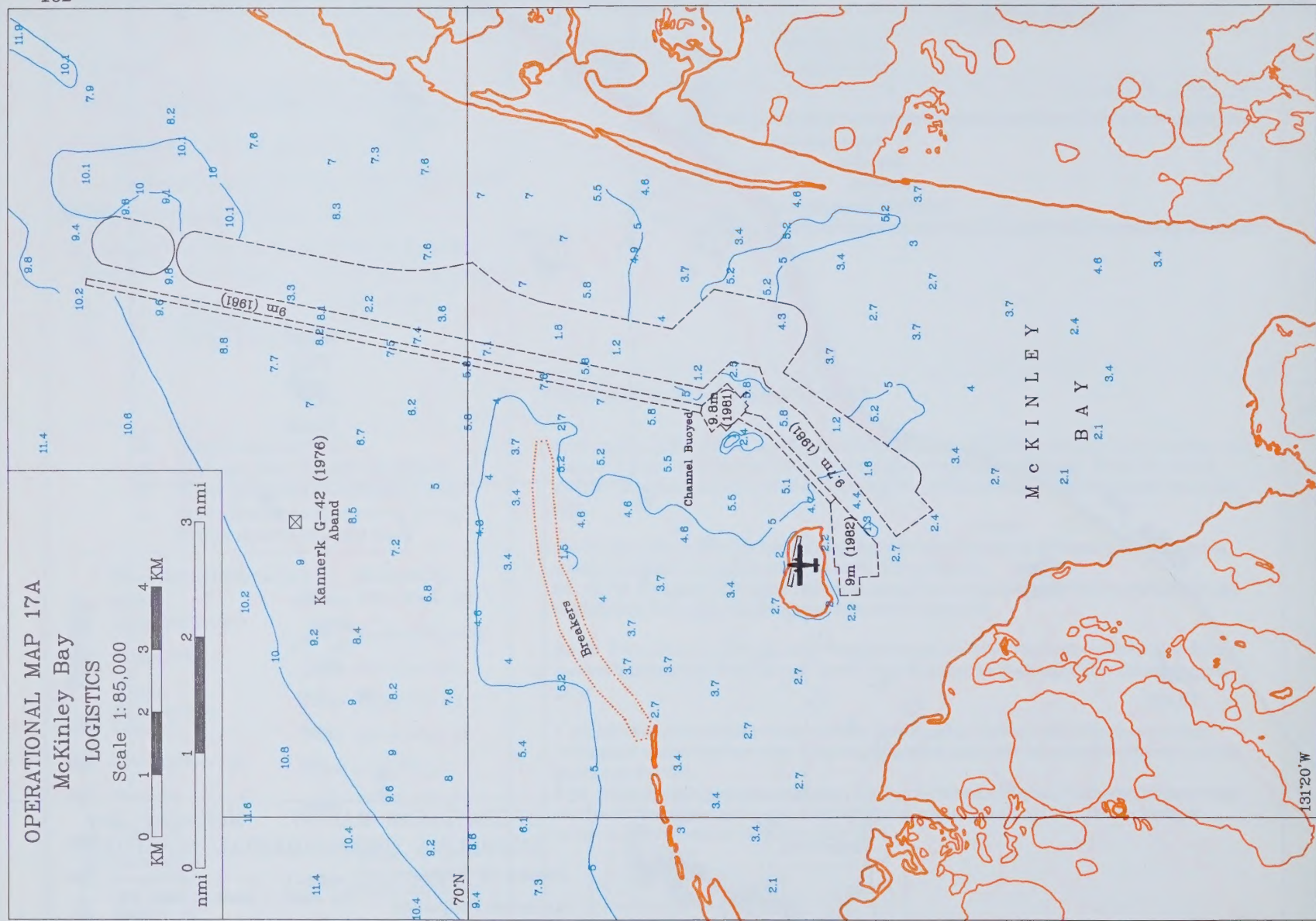
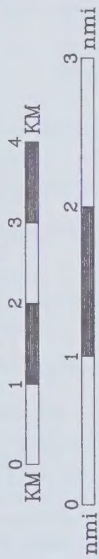


OPERATIONAL MAP 17A

McKinley Bay

LOGISTICS

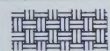
Scale 1:85,000



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 17A McKINLEY BAY ANCHORAGE

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - McKinley Bay, Map 17

Hydrographic Chart - 7663

Video Tapes - AGC 3, 4 Dome 15, 16, 27

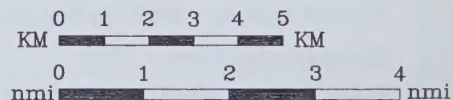
Access:

A dredged channel and mooring basin provides safe anchorage for vessels drawing up to 9 m. A lighted fairway buoy is moored near the entrance to the channel. An artificial island composed of dredge spoil protects the mooring basin from northerly winds and from ice movements in winter. A sand airstrip is located on the island, and winter airstrips have been built in previous years on the ice south of the mooring basin. While nearshore depths may allow beaching of shallow draft barges at certain locations, note that water depths are strongly influenced by prevailing winds.

Countermeasures:

The McKinley Bay area is an important one for the nesting, molting and staging of waterfowl. Oil entering the bay should be contained for recovery, or, if necessary, concentrated and diverted to sand beaches that can be accessed and cleaned. The relatively protected waters of McKinley Bay should allow effective containment operations. Containment booms could be used to prevent oil from contaminating the breached lakes at the head of the bay. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Barge access may be possible at some locations along the eastern shore of the bay. Potential disposal sites are identified near Atkinson Point and near the eastern entrance to McKinley Bay (Map 17).



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 18 NUVORAK POINT

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
E	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - McKinley Bay, Map 17

Hydrographic Chart - 7663, 7664

Video Tapes - AGC 3, Dome 16

Access:

Crescent Bank offers some protection from offshore winds. The safest anchorage is found at McKinley Bay (46 km southwest) to a depth of 9 m (Map 17).

Vessels drawing less than 3 m can approach within 1,300 m of Nuvorak Point (Cape Brown). A radar beacon is situated on Nuvorak Point, mounted on a 9.1 m tower. The mixing of cold and warm air between Atkinson Point and Baillie Islands restricts visibility to about 10 km throughout the navigation season. Once behind Crescent Bank, it becomes very difficult to navigate back around the breakers to offshore waters. Small boats can navigate in lee of Crescent Bank between Relief Island and Phillips Island to the offshore region. Channels are narrow and access can be difficult.

Countermeasures:

Offshore countermeasures represent the only practical method of protecting the extensive tundra shoreline and numerous breached lakes in this area. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

The extensive shoreline and numerous breached lakes preclude the effective use of shoreline protection techniques. At the time of a spill, specific bays and breached lakes may be selected for protection by deflector booms; selection of such sites would be based on amounts of oil, prevailing winds, length of shoreline protected per equipment required, and specific threats to wildlife at the time. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Heavy cleanup machinery must not be used on the tundra shoreline. Small-scale manual cleanup may be used in selected areas of heavy contamination: poor seaward access may dictate the use of helicopter-deployed equipment.

OPERATIONAL MAP 18

NUVORAK POINT

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
----------	-----------	---------------------

43	Atkinson Point	75.65
44	Crescent Bank	28.80
45	Nuvorak Point	29.55

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

 White Whale WW Bowhead Whale Bh Polar Bear PB Ringed Seal RS Bearded Seal BS Arctic Fox AF

Reindeer Re or
Caribou Ca

Fish



Anadromous Fish &
Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

DL 43
Re 43, 44, 45
F 43, 44, 45

Oil Exposed on Shoreline

[illegible]

Environmental Description:

DL 43 From mid July to mid to late August, thousands of diving ducks moult and stage in McKinley Bay and adjacent protected coastal waters (3).

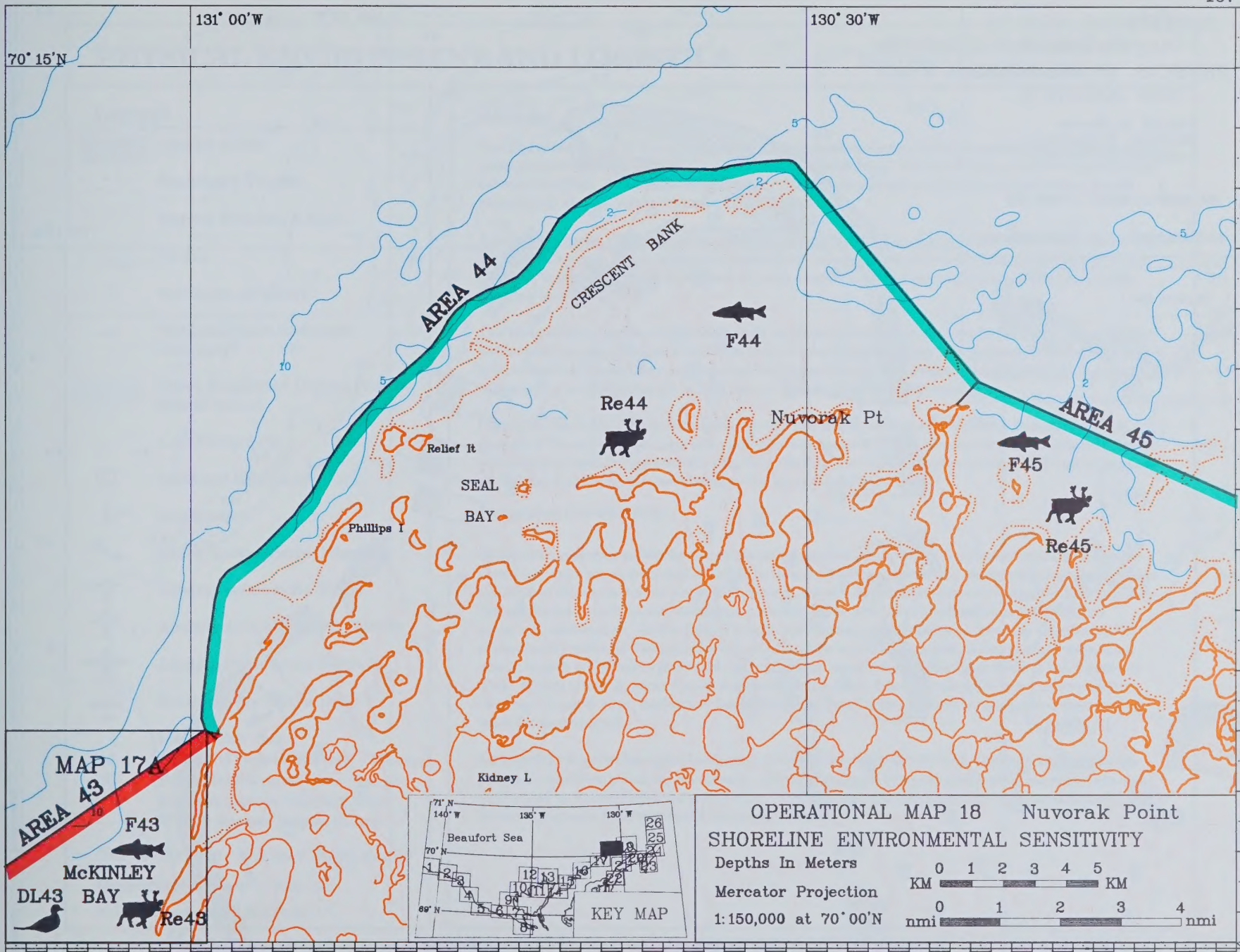
Re 43, 44, 45 From late July through early September, the reindeer herd uses several nearshore areas of Tuktoyaktuk Peninsula to escape from flies during the height of the insect season (27).

F 43, 44, 45 Marine species (including Pacific herring) and Arctic cisco use nearshore areas of Tuktoyaktuk Peninsula for summer feeding (28). Whitefish do not usually occur beyond McKinley Bay (2).

131° 00'W

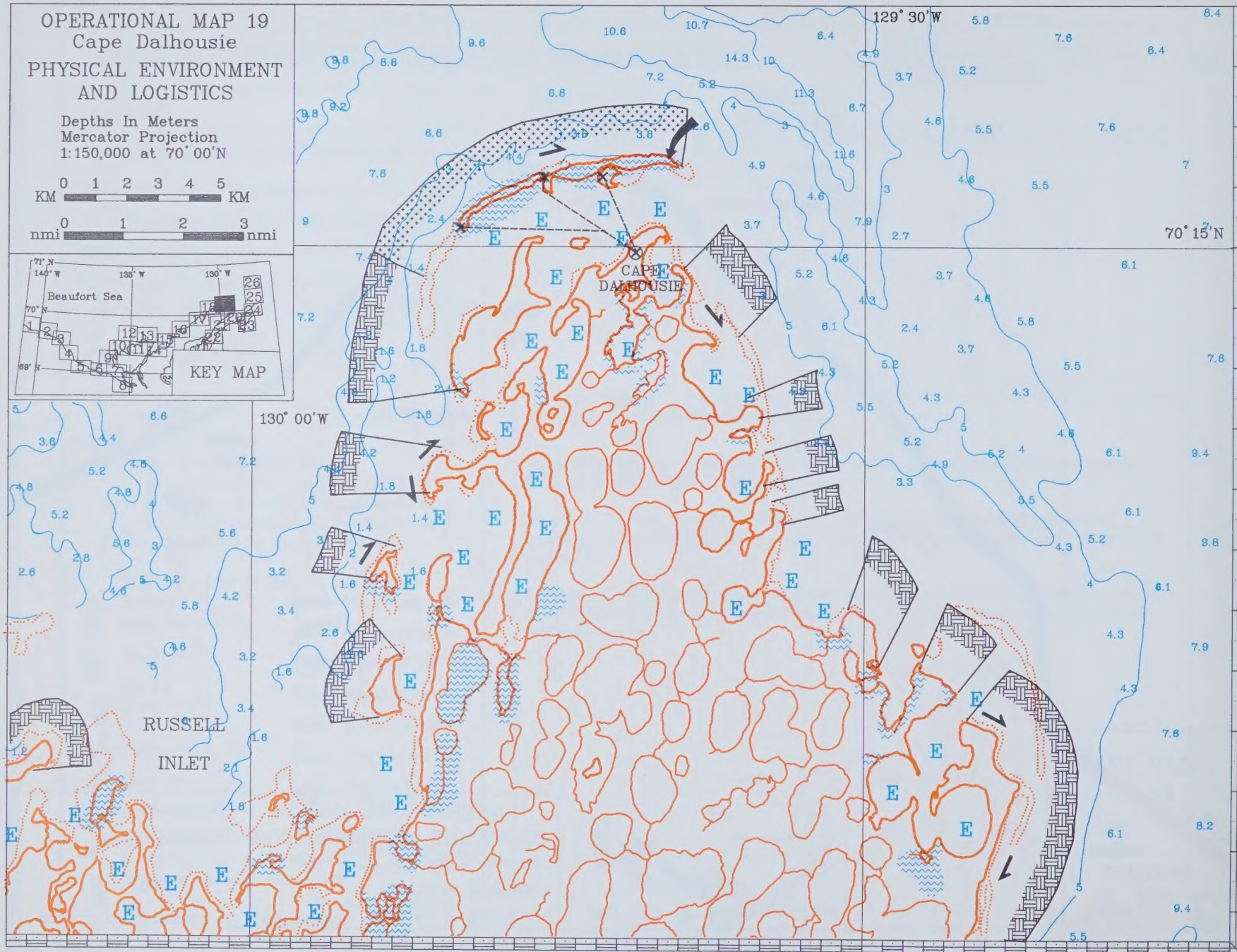
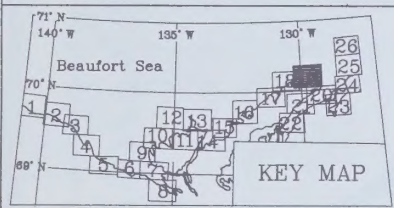
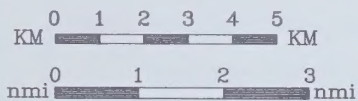
130° 30'W

70° 15'N



OPERATIONAL MAP 19
Cape Dalhousie
PHYSICAL ENVIRONMENT
AND LOGISTICS

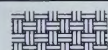
Depths In Meters
Mercator Projection
1:150,000 at 70° 00'N



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 19 CAPE DALHOUSIE

Legend



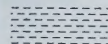
Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7664

Video Tapes - AGC 2, 3 Dome 17

Access:

The 9 m contour lies 11 km offshore from the entrance to Russell Inlet. Vessels drawing less than 3 m can approach within 1.5 km of the east shore of Russell Inlet. This inlet does not afford protection in adverse weather. A red radar reflector beacon, with an elevation of 12.2 m, is situated on a small island lying about 2 km northwest of Cape Dalhousie.

Another red radar reflector beacon, with an elevation of 12.2 m, is situated on Char Point, 18 km SSE of Cape Dalhousie. Ships using the west side of Liverpool Bay should maintain a distance of 11 km offshore, to avoid the shoal area. Access to the shoreline and numerous bays is limited to vessels drawing less than 0.5 m.

The three islands north of Cape Dalhousie provide a sheltered anchorage for boats in 1.8 m of water with a good sand bottom, within 900 m of the eastern island. Enter this harbour from the east. A bar, with a depth of about 1.8 m and trending northsouth, exists at this entrance. Its position is clearly indicated by ice that grounds on it in the early part of the navigation season.

Depths in the vicinity must be expected to change due to erosion and sediment deposition. A tidal stream off Cape Dalhousie has been noted to flow easterly at 1 to 2 knots during a falling tide, and westerly at a similar rate with a rising tide. The normal tidal variation at Cape Dalhousie is up to 0.6 m. Winter airstrips have been built on the ice at Cape Dalhousie.

Countermeasures:

Offshore countermeasures represent the only practical method of protecting the extensive tundra shoreline and numerous breached lakes in this area. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats. The extensive shoreline and numerous breached lakes preclude the effective use of shoreline protection techniques. At the time of a spill, specific bays and breached lakes may be selected for protection by deflector booms; selection of such sites would be based on amounts of oil, prevailing winds, length of shoreline protected per equipment required, and specific threats to wildlife at the time. Where possible, incoming oil may be diverted to sand beaches that are more amenable to cleanup. In particular, the barrier beach fronting Cape Dalhousie may be used as a concentrating point for incoming oil.

Accessibility is poor throughout the area: only the barrier beach at Cape Dalhousie affords barge access for delivering cleanup machinery. Other beaches will require small-scale manual cleanup, if warranted by the degree of contamination. The only potential disposal site in the area is near Cape Dalhousie; it may be accessed via ice road in winter.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 19 CAPE DALHOUSIE

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
46	Russell Inlet	28.35
47	Cape Dalhousie	37.60
48	Char Point	24.75

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting

Areas

- Areas**
Highly Important R
Important R
Fairly Important R
Not Important R

Birds

-  Diving Ducks &
Loons DL
-  Dabbling Ducks DD
-  Geese Ge
-  Swans Sw

- 
- Shorebirds &
Cranes SC
- 
- Seabirds Se

Mammals

- | | | |
|---|------------------------------|----|
|  | White Whale | WW |
|  | Bowhead Whale | Bh |
|  | Polar Bear | PB |
|  | Ringed Seal | RS |
|  | Bearded Seal | BS |
|  | Arctic Fox | AF |
|  | Reindeer Re or
Caribou Ca | |

Fish

-  Anadromous Fish &
Pacific Herring F
-  Site Specific

Occurrence of Species and Resource Use

Re 46, 47, 48

F 46, 47, 48

Oil Exposed on Shoreline

[illegible]

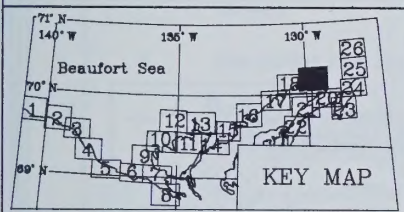
Environmental Description:

Re 46, 47, 48 From late July through early September, the reindeer herd uses several nearshore areas of Tuktoyaktuk Peninsula to escape from flies during the height of the insect season (27).

F 46, 47, 48 Cape Dalhousie and Russell Inlet provide summer feeding habitat for marine species (including Pacific herring) and Arctic cisco (2, 28).

OPERATIONAL MAP 19

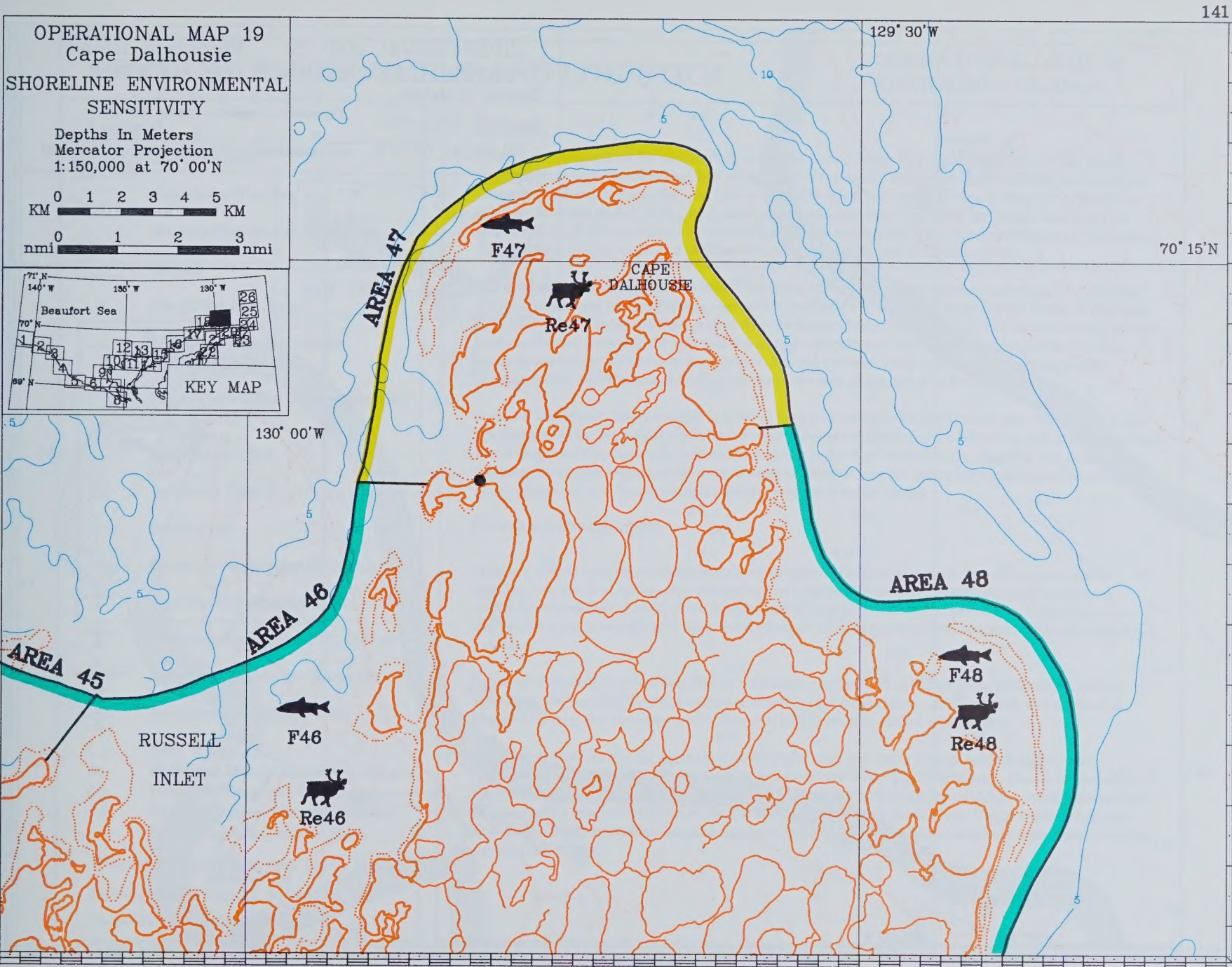
Cape Dalhousie

SHORELINE ENVIRONMENTAL
SENSITIVITYDepths In Meters
Mercator Projection
1:150,000 at 70° 00' N0 1 2 3 4 5
KM0 1 2 3
nmi

129° 30' W

70° 15' N

130° 00' W



OPERATIONAL MAP 20 Nicholson Island PHYSICAL ENVIRONMENT AND LOGISTICS

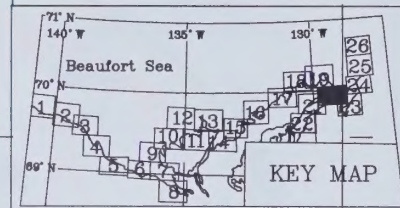
Depths In Meters

Mercator Projection

1:150,000 at 70° 00'N

0 1 2 3 4 5
KM

0 1 2 3 4
nmi



70° 00'N

LIVERPOOL BAY

(750 m)

MAP 20 A
NICHOLSON DEWLINE

NICHOLSON
ISLAND

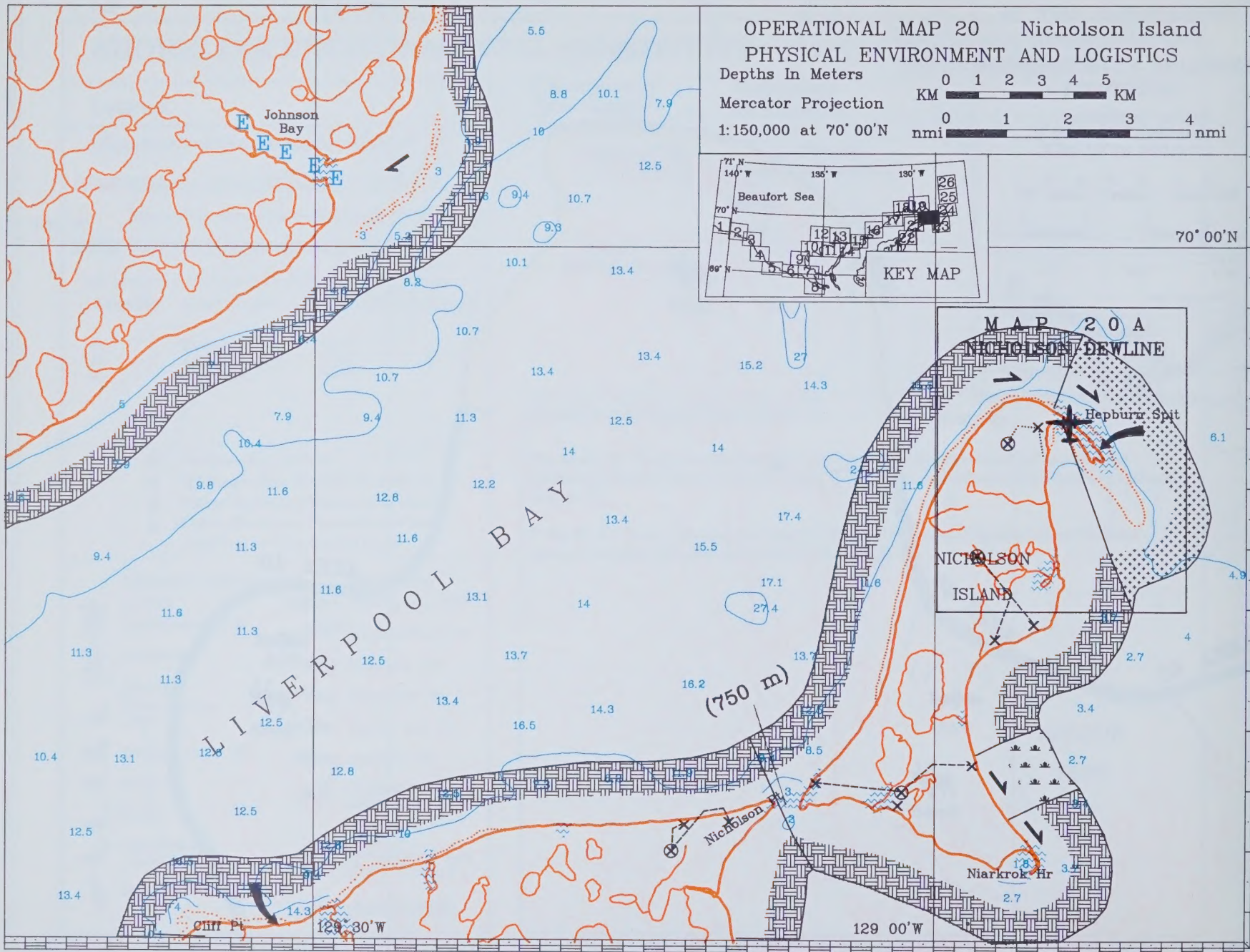
Hepburn Spit

Niarkrok Hr

Chart Pl

129° 30' W

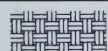
129 00' W



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 20 NICHOLSON ISLAND

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7664

Video Tapes - AGC 2, Dome 17, 18, 24, 25

Access:

Shoal water extends as far as 5 km offshore from Johnson Bay northwards. South of this region shallow-draft barges can be beached along most of the coast. Liverpool Bay has fairly constant mid-channel depths of between 9.1 and 12.8 m to within 7 km of Campbell Island (Map 22). The 750 m inlet at the south end of Nicholson Island provides access into Wood Bay for vessels drawing less than 2 m. A DEW Line station is located about 3 km south from the northern extremity of Nicholson Island. A wind cone and a hut are located at the northwest end of Hepburn Spit.

Niarkrok Harbour and Hepburn Spit (Nicholson Island) provide protected anchorage at a depth of 1.5 m. The normal range of tide is reported to be about 0.5 m. When entering the inside of Hepburn spit, stay clear of breakers that extend 2 km southeast from the sand spit. The depth of water in the harbour formed between the spit and the island varies from 0.9 to 2.1 m. Landing craft can dry-ramp at the beach; barges drawing about 1.5 m are berthed bows-to a bulldozed gravel ramp. Deeper draft vessels can anchor close off the outer side of the spit in 4.9 m of water.

A gravel airstrip on Hepburn Spit is 1045 m long and suitable for year-round use. Wood Bay, to the SE, is suitable for landing floatplanes. Fresh water is available from a lake 3 km SW of Hepburn Spit. Ice in Liverpool Bay normally begins to break-up in the first week of July, clearing two weeks later; freeze-up normally begins in the second week of October, the ice becoming consolidated four weeks later. Break-up and freeze-up dates can vary by up to three weeks.

Countermeasures:

Offshore countermeasures, dispersion or at-or near-source containment for recovery or in-situ burning, are the first options for protecting the Liverpool Bay area. Relatively calm conditions within Liverpool Bay should allow fairly effective nearshore recovery operations. Dispersant use within this area is ecologically warranted when oil threatens waterfowl concentrations or waterfowl habitats.

In terms of shoreline protection, diversion booms may be used to concentrate slicks at accessible sand beaches, thus limiting the extent of shoreline contamination. If threatened, the channel at Nicholson Point and the entrance to Johnson Bay should be sealed with booms.

Beached oil may persist for some time in this relatively low wave energy environment; oiled beaches, especially those in the vicinity of the Anderson River Bird Sanctuary, should be cleaned in a timely manner. Except for Johnson Bay and a few areas with fronting mud flats, most beaches can be accessed by shallow draft barge for the delivery of cleanup machinery. Two potential disposal sites on the north half of Nicholson Island are preferred over the more southerly sites that lie within the bird sanctuary.

OPERATIONAL MAP 20 Nicholson Island SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

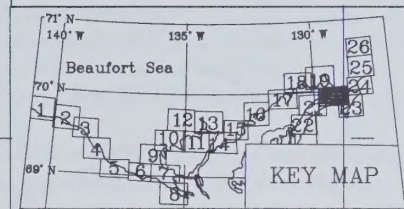
0 1 2 3 4 5

Mercator Projection

KM

1:150,000 at 70° 00'N

0 1 2 3 4 nmi



70° 00'N

AREA 49

LIVERPOOL BAY

AREA 51

AREA 50

MAP 20A
NICHOLSON DEWLINE

Hepburn Spit

NICHOLSON
ISLAND

F50

Ca50

Ca51

F52

Ca52

AREA 52

Niarkrok Hr

Cliff Pt

129° 30'W

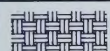
129° 00'W



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 20A NICHOLSON ISLAND DEW LINE

Legend



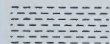
Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7664

Video Tapes - AGC 2, Dome 18

Access:

The bay behind Hepburn Spit provides protected anchorage in 1.5 m of water. The normal tidal range is reported to be about 0.5 m. When entering this bay, stay clear of breakers that extend 2 km southeast from the sand spit. Landing craft can dry-ramp at the beach; barges drawing about 1.5 m are berthed bows-to a bulldozed gravel ramp.

A gravel airstrip on Hepburn Spit is 1045 m long and suitable for year-round use. Fresh water is available from a lake 3 km southwest of Hepburn Spit.

Countermeasures:

Diversion booms may be used to concentrate oil slicks at accessible sand beaches for later cleanup. Of greater importance is to prevent oil from migrating south to the more sensitive Wood Bay/Anderson River area. The relatively protected waters in this area should allow effective containment operations.

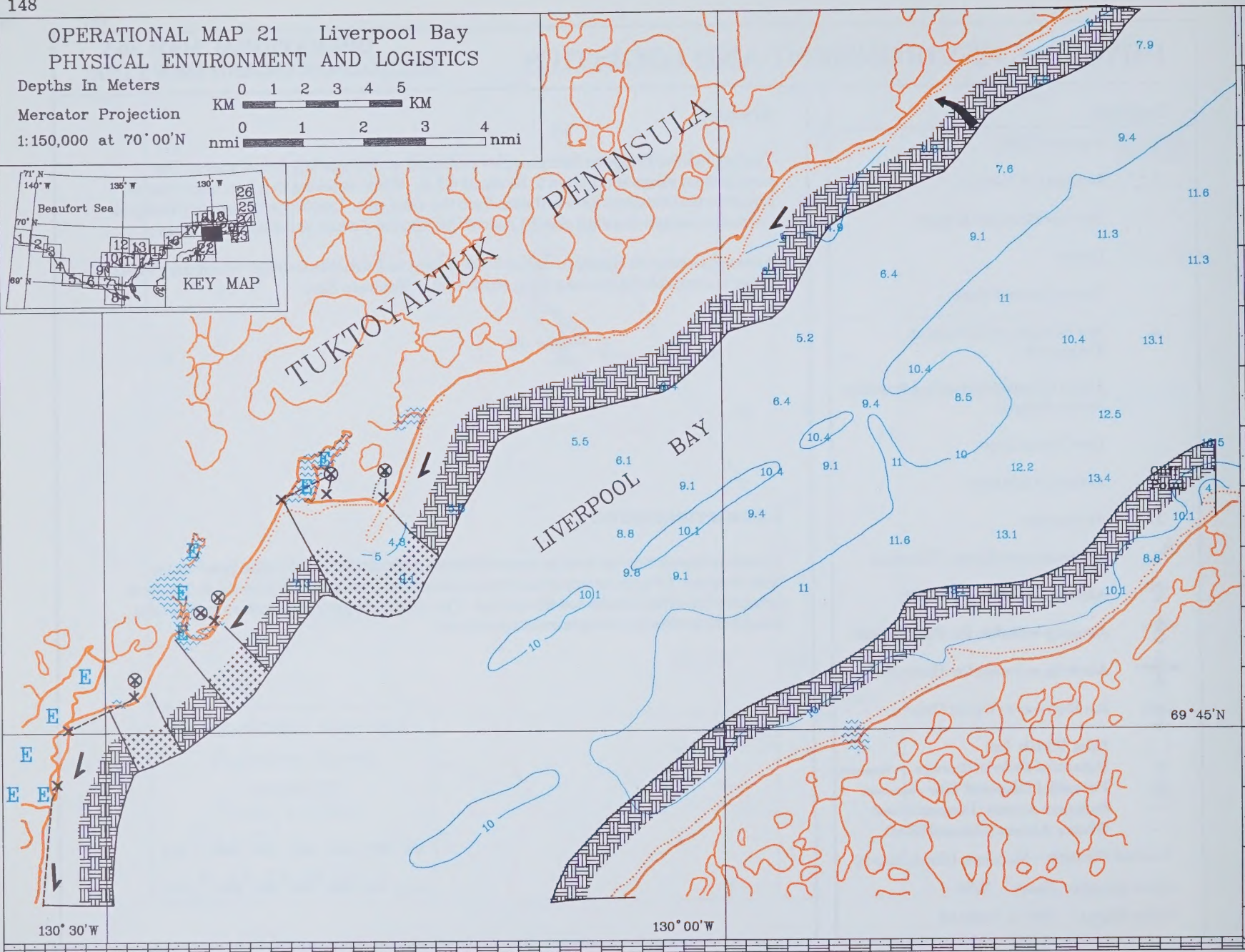
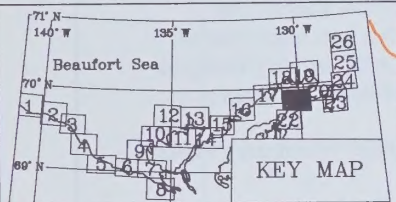
OPERATIONAL MAP 21 Liverpool Bay

PHYSICAL ENVIRONMENT AND LOGISTICS

Depths In Meters

 0 1 2 3 4 5
 KM

Mercator Projection

 1:150,000 at 70°00'N
 nmi 0 1 2 3 4 nmi


PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 21 LIVERPOOL BAY

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7664, 7608

Video Tapes - AGC 2, Dome 18, 21, 22, 23

Access:

Liverpool Bay has a fairly constant mid-channel depth of between 9.1 and 12.8 m to within 7 km of Campbell Island. Shallow draft tugs and barges can be beached along most of the coast. Shallow mud flats front many of the small creeks.

All of Liverpool Bay offers safe shelter during northwesterly winds. The unnamed bay shown on this map offers the best anchorage for all weather, with a depth of 7 m and good holding ground of stiff mud. Tidal streams of up to 2 knots occur in this anchorage.

Countermeasures:

Conventional near-source countermeasures are the first option for shoreline protection. Relatively calm conditions within this area should allow effective containment and recovery or in-situ burning operations. Dispersant use within this area is ecologically warranted when oil threatens waterfowl concentrations or waterfowl habitats.

The vast majority of the shoreline is sand beach. Only two bays (on the northwest coast) may require sealing with boom. Otherwise, oil may be diverted to accessible concentration points for recovery with pumps and skimmers.

Due to the low sensitivity of the area, this area is only a moderate priority for cleaning. Debris and sediment may be barged to temporary stockpiles on the northwest shore of Liverpool Bay, and placed in permanent disposal sites during winter.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 21 LIVERPOOL BAY

Legend

Shoreline Environmental Sensitivity*

-  High Sensitivity Ranking > 68.70
-  Moderate Sensitivity Ranking 35.10 - 68.70
-  Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

53	North Liverpool Bay	13.50
54	Northwest Liverpool Bay	26.20
55	South Liverpool Bay	23.50

-  Archaeological Site
-  Heritage Site - locally identified
-  Major Resource Harvesting Camp
-  Other Resource Harvesting Camp
-  National or Territorial Park

Resource Harvesting

Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

 White Whale WW

 Bowhead Whale Bh

 Polar Bear PB

 Ringed Seal RS

 Bearded Seal BS

 Arctic Fox AF

 Reindeer Re or Caribou Ca

Fish

 Anadromous Fish & Pacific Herring F

 Site Specific

Occurrence of Species and Resource Use

F 53, 54, 55

Oil Exposed on Shoreline											
May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr

Environmental Description:

F 53, 54, 55 Liverpool Bay provides important habitat for marine species. Pacific herring spawn in shoreline areas during the spring (29, 35). The importance of this area for coregonids is presently unknown.

OPERATIONAL MAP 21 Liverpool Bay
SHORELINE ENVIRONMENTAL SENSITIVITY

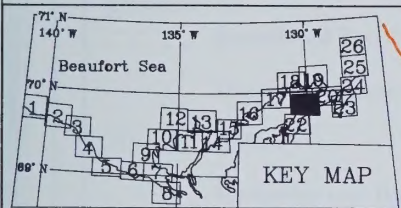
Depths In Meters

Mercator Projection

1:150,000 at 70°00'N

0 1 2 3 4 5
KM

0 1 2 3 4
nmi



TUKTOYAKTUK PENINSULA

F54

AREA 54

BAY

LIVERPOOL

AREA 53

F53

AREA 55

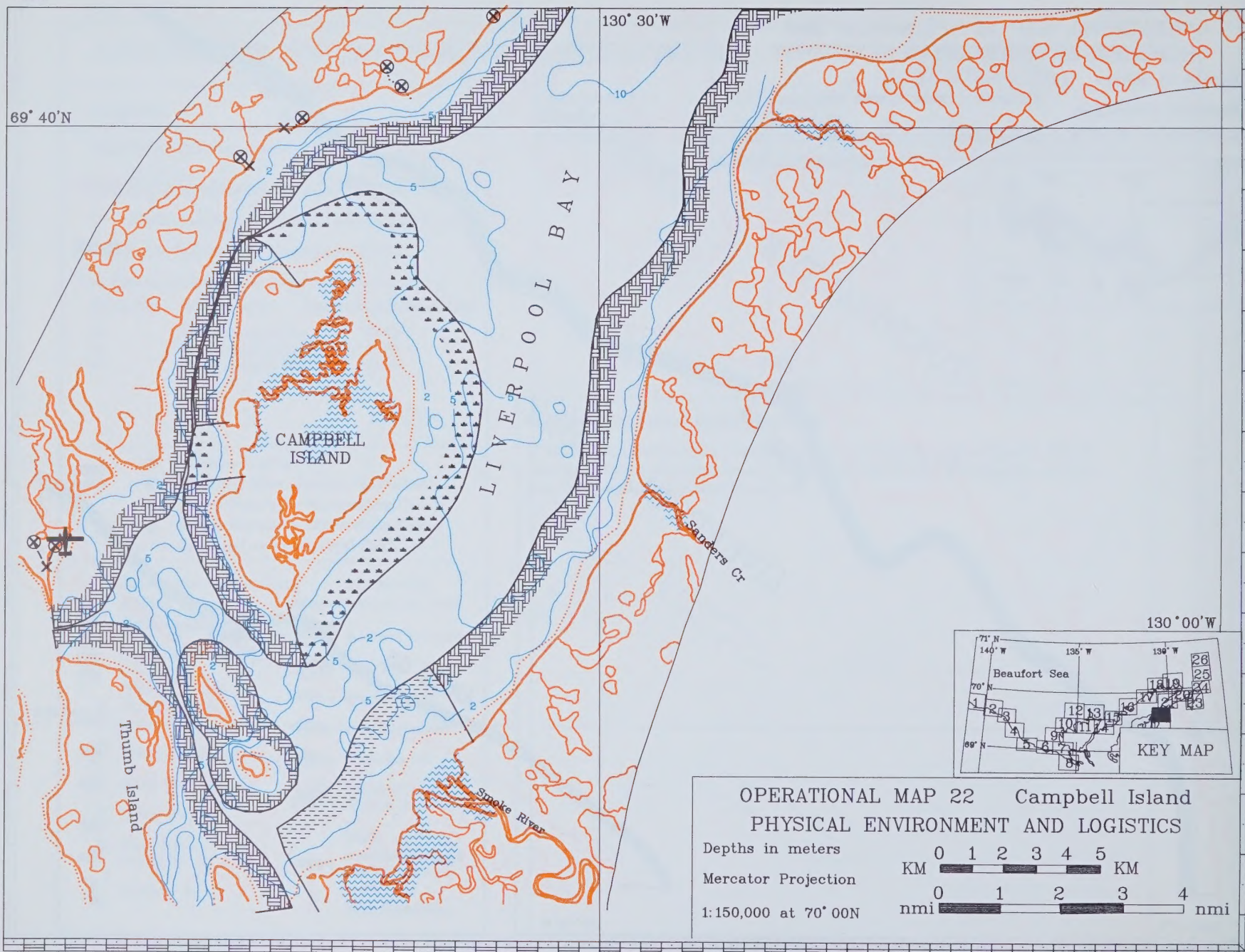
F55

Cliff Point

69°45'N

130°30'W

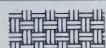
130°00'W



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 22 CAMPBELL ISLAND

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas



Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7608

Video Tapes - AGC 2, Dome 22, 23

Access:

An anchorage off Sanders Creek offers good holding in 6 m over a stiff mud bottom. Strong tidal streams of 1 to 3 knots have been experienced. The flood stream is both longer and stronger than the ebb, running about 7 hrs.

The most destructive storms and winds are from the west; they may raise the water levels by more than 1.5 m to submerge the offshore sand bars and flood the coastal areas. NE winds, while usually of less strength, are commonly of longer duration and, due to a funnelling effect, can cause rough seas between Nicholson Island and Campbell Island.

The recommended track on the east side of Campbell Island is encumbered with off-lying shoals with 0.8 m over them; toward the south end of this route the bottom is very uneven and strong winds can make navigation dangerous. Two tundra airstrips, for winter use, are located at Smoke River.

Countermeasures:

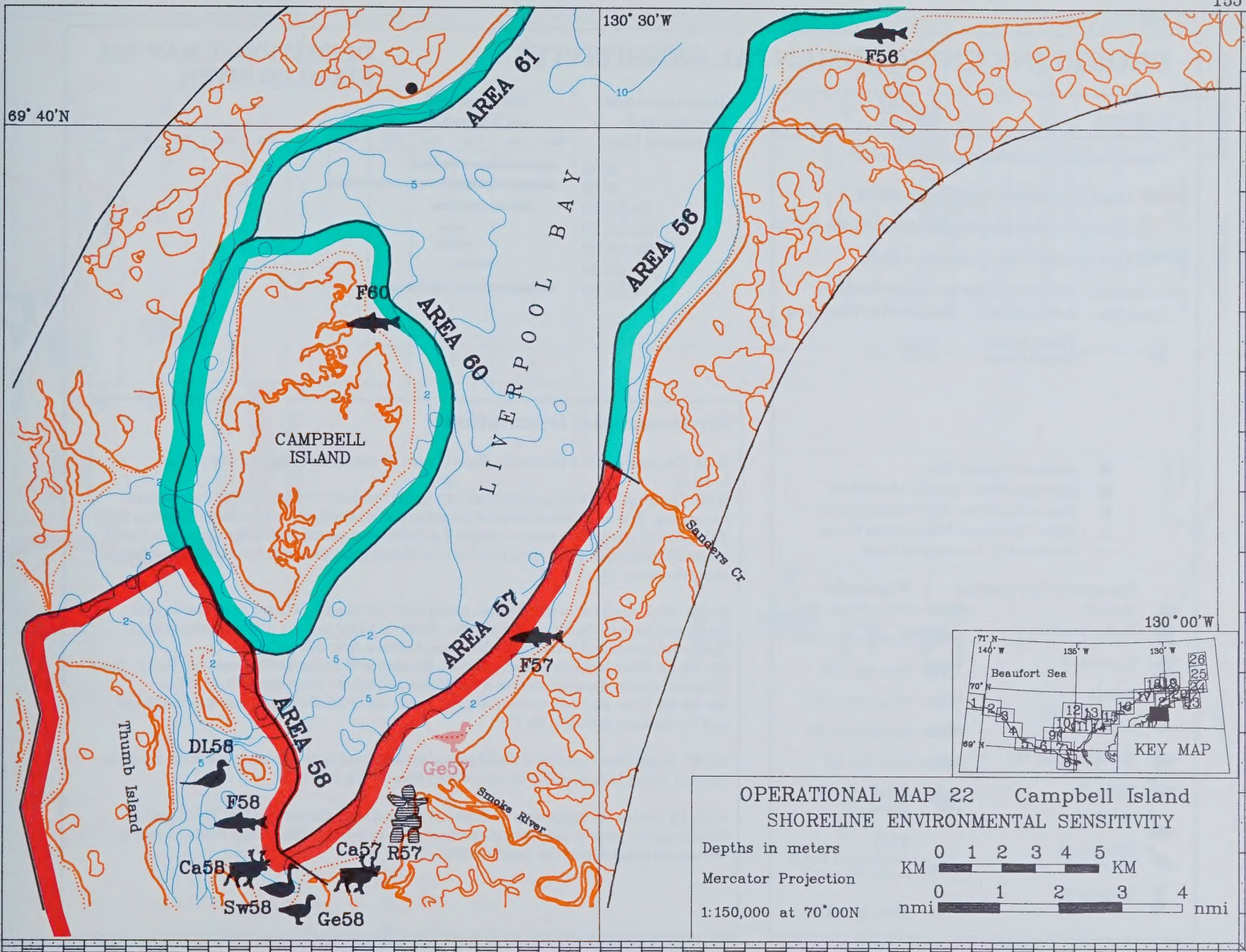
Conventional near-source countermeasures are the first option for shoreline protection. Relatively calm conditions within this area should allow effective containment and recovery or in-situ burning operations. Dispersant use within this area is ecologically warranted when oil threatens waterfowl concentrations or waterfowl habitats.

High priority should be given to protecting the Smoke and Moose River deltas and Thumb Island, and ensuring that oil does not travel southwest of this area (i.e., to the Kugalluk River, Map 22A). Oil may be diverted to the sand beaches northeast of Smoke River. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Oiled beaches near the Smoke River delta should be cleaned in a timely manner considering its use as a nesting, molting and feeding area. Other contaminated beaches may be cleaned at a later date, in which case monitoring should be carried out to ensure that oil does not migrate to the southwest. Cleanup machinery may be delivered by barge to most points along the coast, although mudflats will restrict access at some locations.

Potential debris disposal sites are identified on the northwest coast.

F 56, 57, 58, 60, 61 Liverpool Bay provides important habitat for marine species throughout the year. Pacific herring spawn in shoreline areas during spring (29, 35). The importance of this area for coregonids is presently unknown.



SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 22A KUGALUK RIVER

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

58	Thumb Island	78.65
59	Kugaluk River	87.25

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

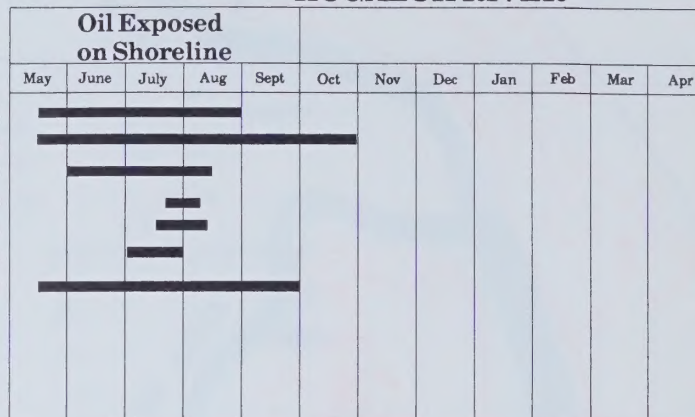
Reindeer Re or Caribou Ca

Fish

Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use



Environmental Description:

R 58 The area south of the Smoke River is used for spring bird hunting and caribou hunting.

R 59 The Kugaluk River area is important to the residents of Tuktoyaktuk for resource harvesting. It is an excellent area for trapping and bird and caribou hunting. Families from Tuktoyaktuk often overwinter at camps that have been established in the area. It is also of cultural importance; there are a number of archaeological sites that have been identified along the coast.

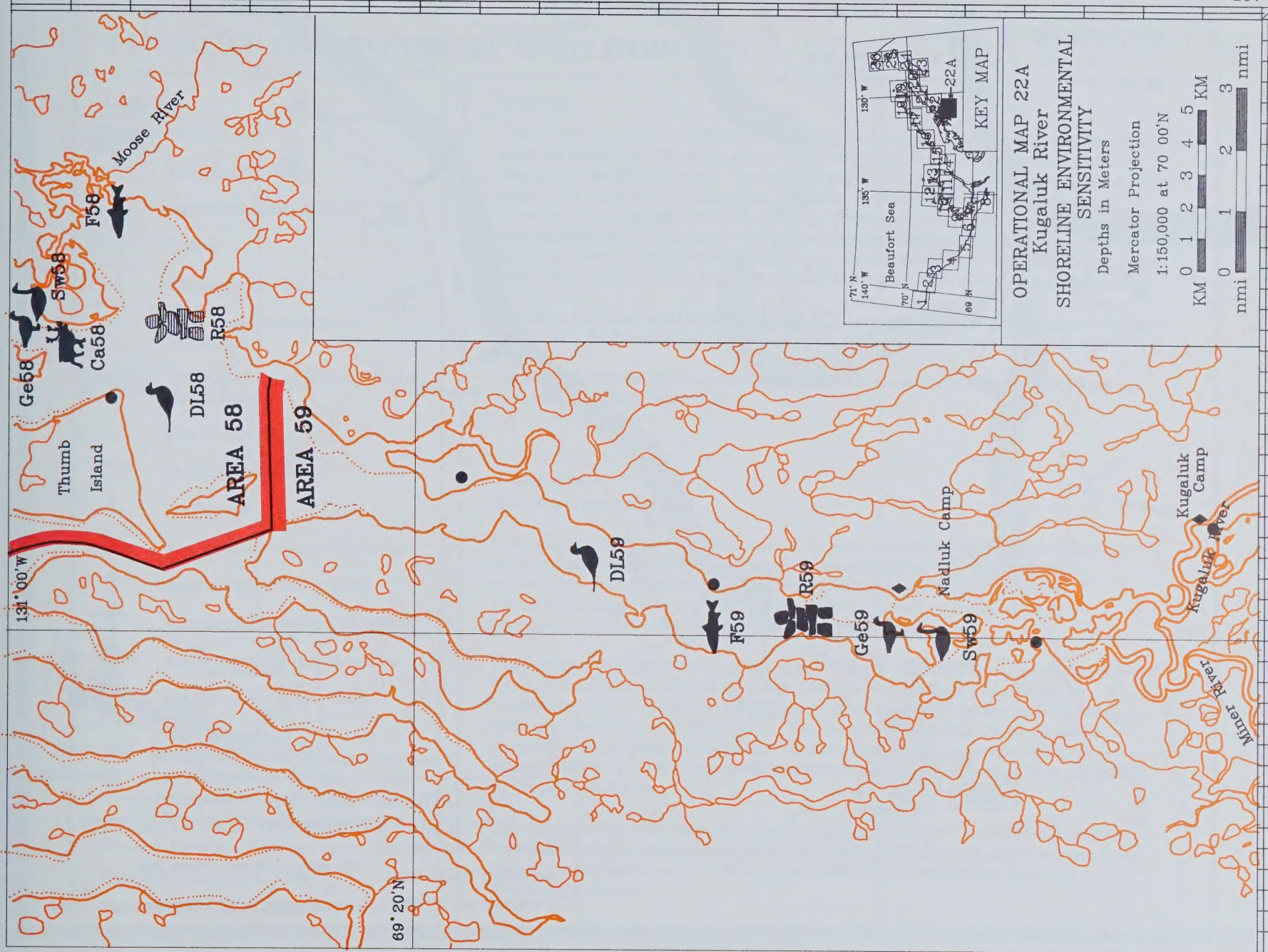
Ge 58, 59 From June to mid August, hundreds to thousands of brant nest, rear broods, moult and stage in the Moose River delta. From mid July to early August, thousands of geese rear broods and moult in the Moose and Smoke river deltas (3, 36, 37).

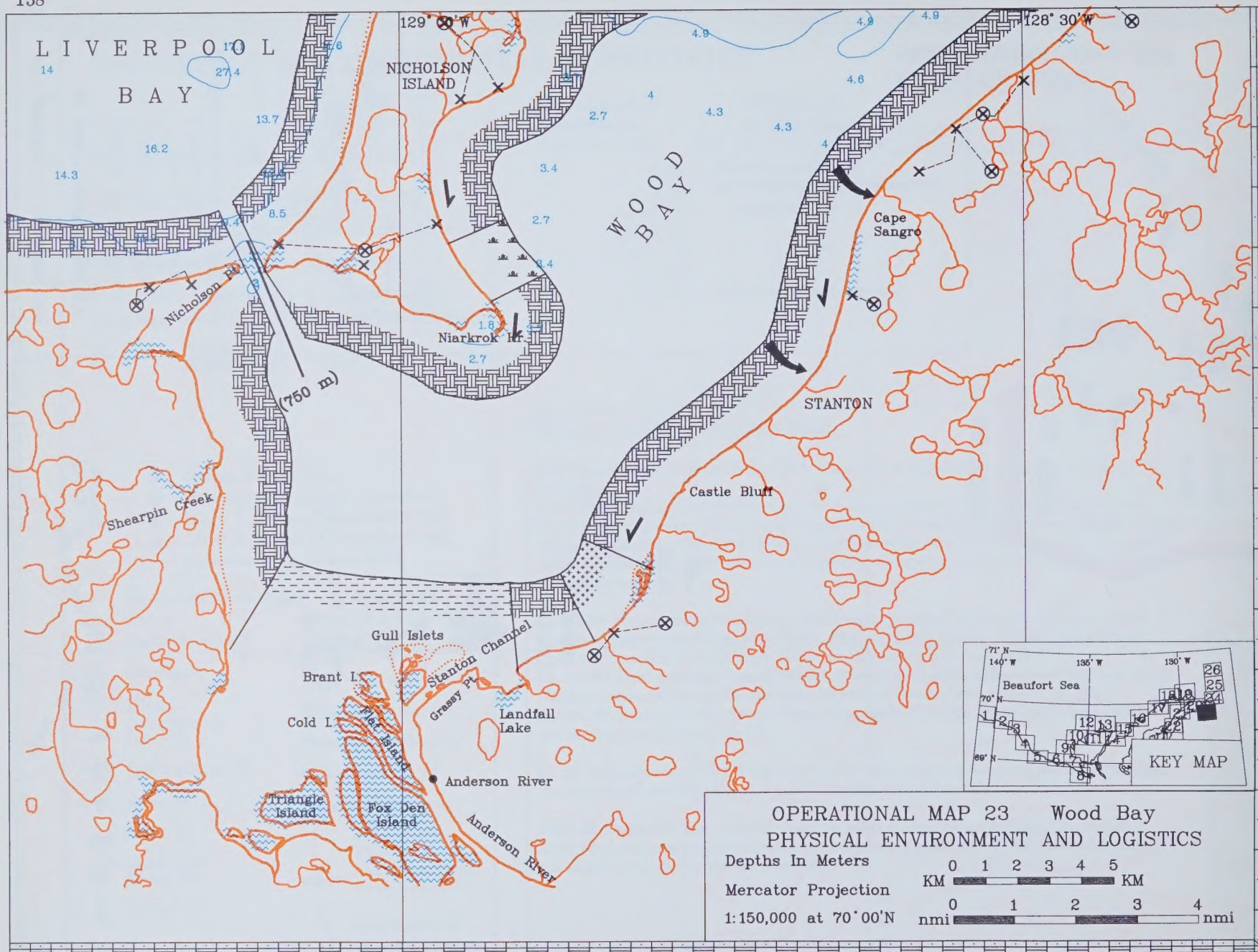
DL 58, 59 From late July to early August, thousands of diving ducks moult and feed in the "Fingers" area and east and south of the Moose and Smoke river deltas (3, 36, 37).

Sw 58, 59 From mid July to early August, hundreds of tundra swans moult in the Moose and Smoke river deltas (3, 36, 37).

Ca 58 A significant portion of the Bluenose caribou herd may use some nearshore areas on the east side of Liverpool Bay to escape from flies during July (40).

F 58, 59 Pacific herring spawn in shoreline areas during the spring (35). The Kugaluk River supports large populations of anadromous coregonids, which likely feed and rear in the coastal areas during the summer (38).

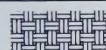




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 23 WOOD BAY

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas



Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map20

Hydrographic Chart - 7664

Video Tapes - AGC 1, Dome 18, 24, 25

Access:

The normal approach into Wood Bay is along the eastern mainland side. Shallow draft tugs and barges can dry ramp along most of the beach between Castle Bluff and Cape Sangro in about 1 m of water. Strong east winds will lower the water level of Wood Bay up to 0.5 m while strong west winds will raise it as much as 0.8 m above normal. Normal tides in Wood Bay are about 0.6 m. Depths are unmarked, however the approach into Anderson River is through the eastern distributary channel of the delta. Vessels drawing 0.9 or 1.2 m can navigate the channel and proceed as far as Husky Bend, 32 km upstream. The channel is between 180 and 270 m wide with mud flats on each side.

Niarkrok Harbour and Hepburn Spit (Map 20) provide protected anchorage at a depth of 1.5 m. The Anderson River channel provides anchorage at a depth of about 1 m.

Ice in the Anderson River is reported to break-up about the middle of June; freeze-up commences in late September.

Countermeasures:

Conventional offshore countermeasures, dispersion or containment for recovery or in-situ burning, are the first options for shoreline protection. The relatively calm conditions in Wood Bay should allow fairly effective nearshore containment operations. Dispersant use within this area is ecologically warranted when oil threatens waterfowl concentrations or waterfowl habitats.

The highest protection priority is to prevent oil from reaching the southern part of Wood Bay and the Anderson River Delta area. Oil approaching Castle Bluff could be diverted to onshore collection points, ideally at locations that are accessible by barge and near temporary debris stockpiles. The channel at Nicholson Point should be sealed if oil slicks threaten Wood Bay via that route. If large numbers of flightless diving ducks are present, helicopters and boats should be used to herd birds away from oil contaminated areas.

Cleanup machinery can be delivered by shallow draft barge to most of the shoreline near Cape Sangro. Potential disposal sites near Cape Sangro are preferred over those sites in the bird sanctuary; however, care must be taken not to disturb nearby archaeological sites.

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
50	Nicholson Island	21.25
51	Cliff Point	20.50
52	Anderson River	102.30
62	Mason River	64.45

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

- | Areas | Highly Important R | Important R | Not Important R |
|------------------------------|--------------------|-------------|-----------------|
| 1. Physical | | | |
| 2. Emotional | | | |
| 3. Intellectual | | | |
| 4. Social | | | |
| 5. Self-actualization | | | |
| 6. Transcendental | | | |

Birds

-  Diving Ducks & Loons DL
-  Dabbling Ducks DD
-  Geese Ge
-  Swans Sw
-  Shorebirds & Cranes SC
-  Seabirds Se

Mammals

- | | | |
|---|------------------------------|----|
|  | White Whale | WW |
|  | Bowhead Whale | Bh |
|  | Polar Bear | PB |
|  | Ringed Seal | RS |
|  | Bearded Seal | BS |
|  | Arctic Fox | AF |
|  | Reindeer Re or
Caribou Ca | |

Fish

-  Anadromous Fish & Pacific Herring F
-  **Site Specific**

Occurrence of Species and Resource Use

R 52
Ge 52
Sc 52
DL 52, 62
DD 52
Sw 52
Ca 50, 51, 52, 62
F 50, 51, 52, 62

Oil Exposed on Shoreline

[illegible]

Environmental Description:

R 52 This area is important to the residents of Tuktoyaktuk. The old Stanton site is an important heritage site, and several archaeological sites have been identified along the coast. A camp is often established in the area for fishing in summer and trapping in winter.

SC 52, Ge 52 From June through early to mid August, individual Eskimo Curlews may occur in the Anderson River delta. At this time, hundreds to thousands of brant and other geese nest, rear broods, moult and stage in the delta and deltas of three small creeks south of Nicholson Point (3, 26).

DL 52, 62, DD 52 From early July to mid August, thousands of diving ducks moult and stage in the nearshore areas of Wood Bay and north along the coast to the Mason River delta. At this time, thousands of dabbling ducks congregate in the Anderson River delta and the lower Anderson River valley (3).

Sw 52 From early July to late August, hundreds of tundra swans moult and stage in the Anderson River delta (3).

Ca 50, 51, 52, 62 A significant portion of the Bluenose caribou herd may use nearshore areas around Nicholson Peninsula and the west side of Liverpool Bay to escape from flies during July (40).

F 50, 51 Liverpool Bay provides important habitat for a number of marine species including Pacific herring, but its importance for coregonids is presently unknown (29, 35).

F 50, 52 The Anderson River supports populations of Arctic cisco, least cisco and whitefish (2), which likely use coastal areas for feeding during the summer. Some fish may overwinter in river channels.

F 62 There is limited information regarding the fish species and their distribution in this area (2). However, it is likely that anadromous species from the Anderson River use coastal areas during the summer.

LIVERPOOL
BAY

AREA 50

129° 00' W
NICHOLSON
ISLAND

AREA 51

F51

Ca51

Nicholson Pt

Ca50

F50

Niarkrok Hk

WOOD
BAY

AREA 62

DL62

F62

Ca62

Cape Sangro

128° 30' W

Shearpin Creek

AREA 52

DL52

Brant I.

Cold I.

F52

Sw52

Triangle Island

Ca52

Flat Island

Fol Den Island

DD52

Gull Islets

Stanton Channel

SC52

Landfall Lake

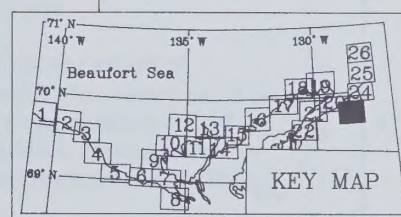
Anderson River
(Abandoned)

Anderson River

R52

Castle Bluff

STANTON



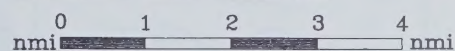
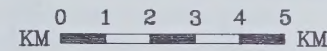
OPERATIONAL MAP 23 Wood Bay

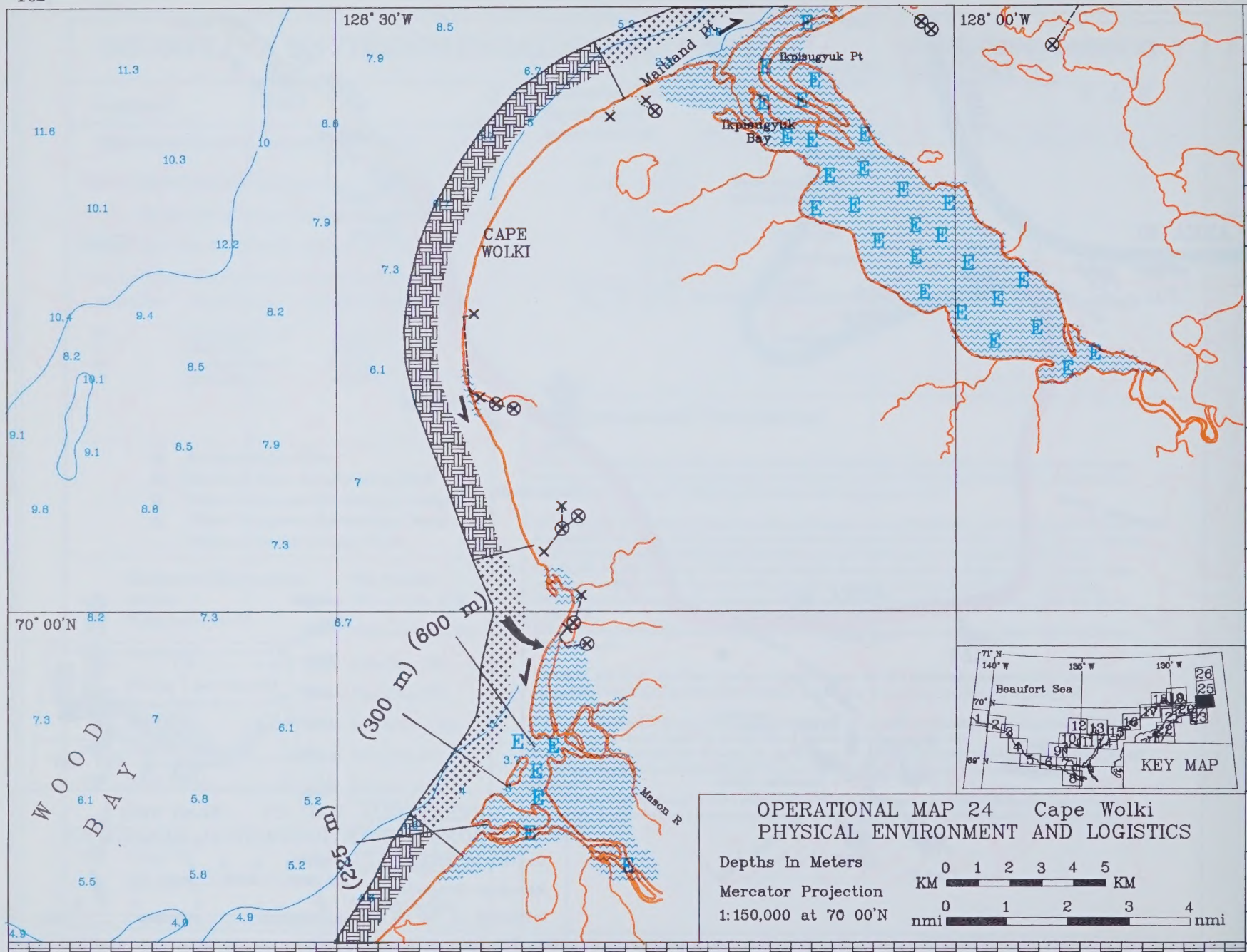
SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

Mercator Projection

1:150,000 at 70° 00' N

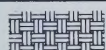




PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 24 CAPE WOLKI

Legend



Tundra Cliffs



Inundated Tundra



Barrier Beaches & Spits



Deltas

E

Estuaries and Bays



Net Longshore Sediment Transport



Areas Inundated During Positive Storm Surges



Low Water Line



Artificial Islands



Anchorage



Shore Access (Barge Offloading)



Airstrip suitable for STOL



Airstrip suitable for F27, HS748



Airstrip suitable for Hercules



Ice Runways (Winter Only)



Inlet Width (m)



Potential Debris Storage - Temporary



Potential Disposal Site - Permanent



Summer Access (Disposal Sites)



Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7664

Video Tapes - AGC 1, Dome 18, 19, 25

Access:

The 2 m contour lies about 200 m offshore. Vessels can approach closer to shore near Cape Wolki. Shallow draft tugs and barges can dry-ramp along most of the beach between Ikpisugyuk Point and Mason River. When approaching beaching areas, note that the contour and composition of the bottom may be altered from year to year due to ice action. Depths fronting the Mason delta are shallower than reported: 2.4 km off the middle spit, depths are 1.2 m. A sand bar, sometimes exposed at low tide, appears to front the entire delta. A narrow 1.5 m deep channel is reported on the south end of the delta.

Hepburn Spit (Map 20), 20 km west, provides protected anchorage at a depth of 1.5 m. Deeper draft vessels can anchor close off the outer side of the spit in 4.9 m of water. Areas near the shore all along Harrowby Bay (Map 25) and off Cape Wolki offer temporary shelter during north and easterly winds.

Countermeasures:

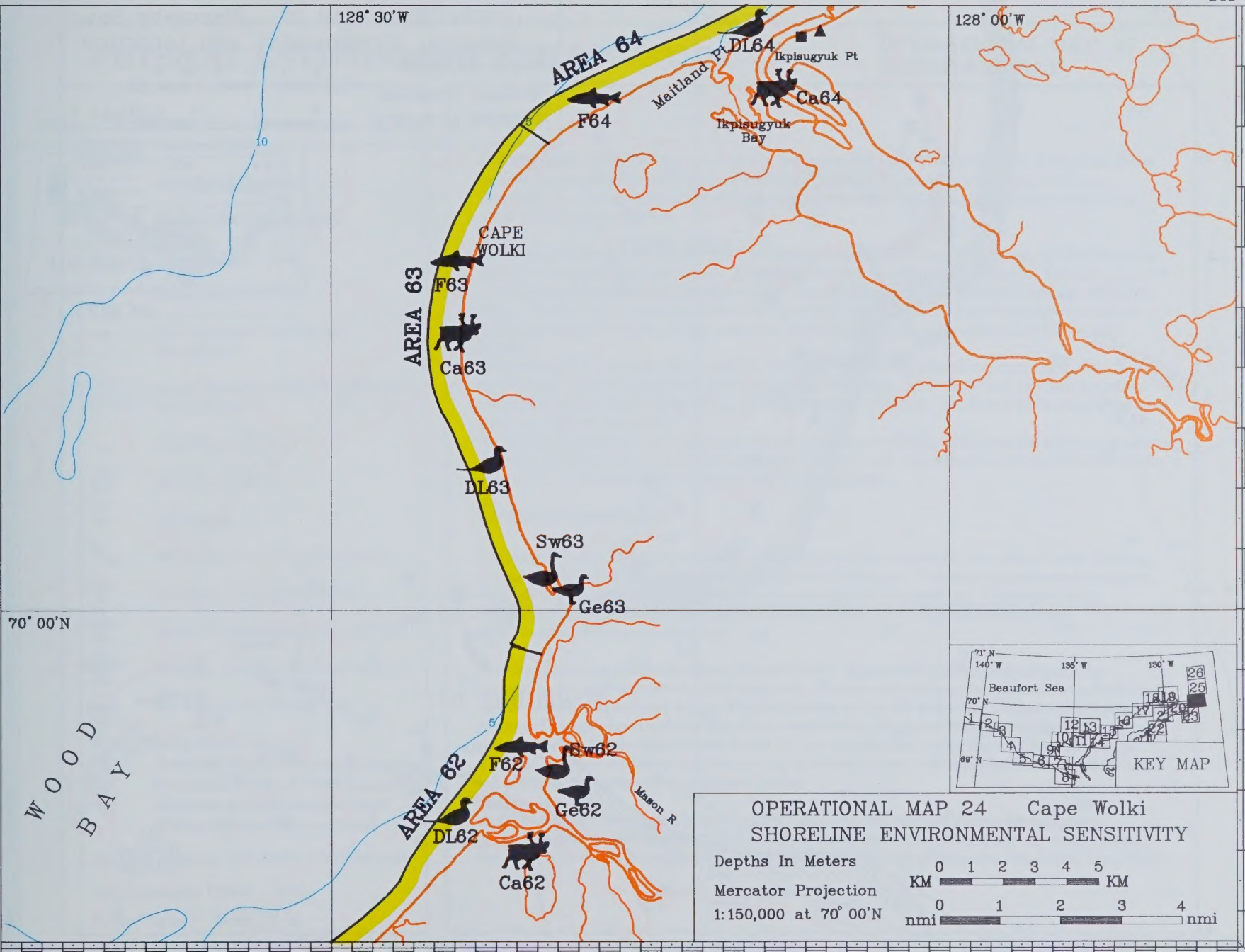
Conventional offshore countermeasures, dispersion or containment for recovery or in-situ burning, are recommended subject to weather and logistical limitations. The relatively protected waters of this area should allow fairly effective nearshore containment operations. Dispersant use is ecologically justified within this area when oil threatens waterfowl concentrations or waterfowl habitats.

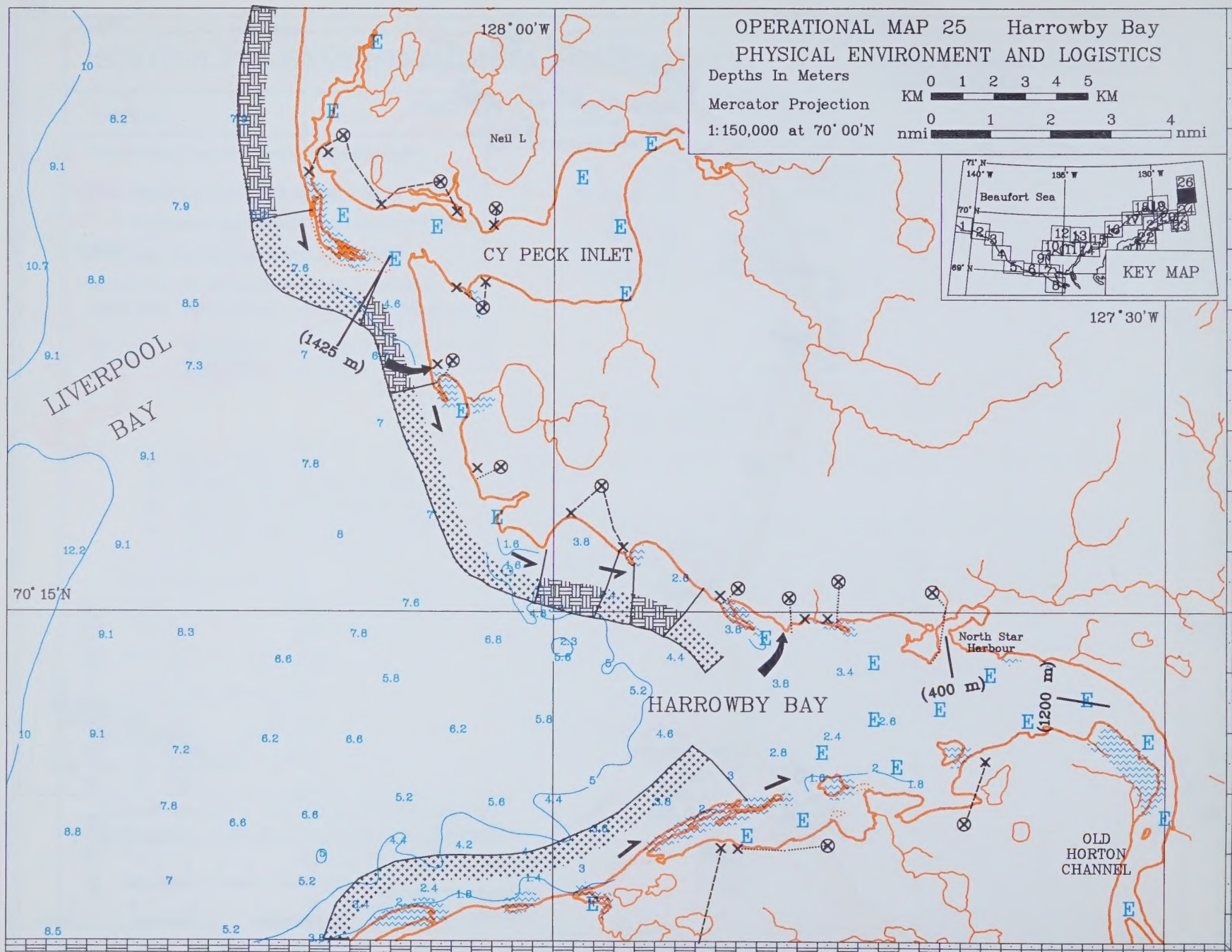
This area is identified as of moderate sensitivity. In order to limit the extent of inshore contamination, the Mason River delta and the Maitland Point estuary could be protected by diverting incoming oil to less sensitive sand and gravel beaches on either side. Pumps and skimmers could be used to recover the diverted oil. If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Cliff and gravel shorelines that are not heavily oiled may not require active cleaning. Shallow draft barges can be beached along most of the coast for the delivery of cleanup machinery. Numerous potential disposal sites are identified; each requires winter access except for those immediately east and west of Maitland Point, which can be accessed during summer.

128° 30' W

128° 00' W





PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 25 HARROWBY BAY

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island Map 20

Hydrographic Chart - 7664

Video Tapes - Dome 19, 26

Access:

Uniform depths of about 3.4 m are found in Harrowby Bay. Old Horton Channel, at the head of the bay, can be navigated for approximately 16 km by small boats drawing 1 m. Water levels in Harrowby Bay are greatly influenced by winds; strong west winds will raise the water level by as much as 0.8 m above normal.

North Star Harbour provides protected anchorage at a depth of 1 m. The entrance to the harbour is difficult to identify from more than 1.5 km offshore due to overlapping headlands. The entrance is partially closed by sand bars but the channel through the bars is over 30 m wide and not difficult to follow. Depths of 2.7 m continue for 1.6 km once inside the entrance. Boats drawing 0.9 m can lie alongside the gravel beach. Fresh water can be obtained from small ponds within 300 m of the harbour.

The entrance into Cy Peck Inlet is about 1,000 m wide with a sand bank on the western side. Sand bars exposed at low tide continue across most of the entrance. Entry into Cy Peck Inlet is possible through a narrow channel adjacent to the eastern cliffed shoreline. Small boats drawing a little more than 1 m can enter the inlet.

Vessels drawing more than 1 m can anchor behind the main Baillie Island and the sand spit projecting from Cape Bathurst 20 km north (Map 26). Anchorage in 2.1 m of water is available 90 m offshore in the shelter of the hook at the northwest end of the sand spit.

Countermeasures:

Conventional offshore countermeasures, dispersion or containment for recovery or in-situ burning, are recommended subject to weather and logistical limitations. The relatively protected waters in this area should allow fairly effective nearshore containment operations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

In order to limit the extent of inshore contamination, oil approaching Harrowby Bay may be diverted to the sand beaches on either approach. For the same reason, the entrance to Cy Peck Inlet may be sealed with deflector booms. Prime diversion points are those near temporary stockpiles for reasons of ease of access and transfer of recovered debris. Should oil enter Harrowby Bay, seal the entrance to North Star Harbour and divert oil from the entrance to Old Horton Channel (head of the bay). If large numbers of flightless diving ducks are present, helicopters or boats should be used to herd birds away from oil contaminated areas.

Most beaches can be accessed by shallow draft barge for this delivery of cleanup machinery. Numerous potential disposal sites are identified, most can be accessed only during winter. Avoid the use of sites in the immediate vicinity of North Star Harbour as there is an important camp there.

SHORELINE ENVIRONMENTAL SENSITIVITY

OPERATIONAL MAP 25 HARROWBY BAY

Legend

Shoreline Environmental Sensitivity*

- High Sensitivity Ranking > 68.70
- Moderate Sensitivity Ranking 35.10 - 68.70
- Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No. Area Name Sensitivity Ranking

64	Maitland Point	62.30
65	Harrowby Bay	92.30
66	Cy Peck Inlet	27.40

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

White Whale WW

Bowhead Whale Bh

Polar Bear PB

Ringed Seal RS

Bearded Seal BS

Arctic Fox AF

Reindeer Re or Caribou Ca

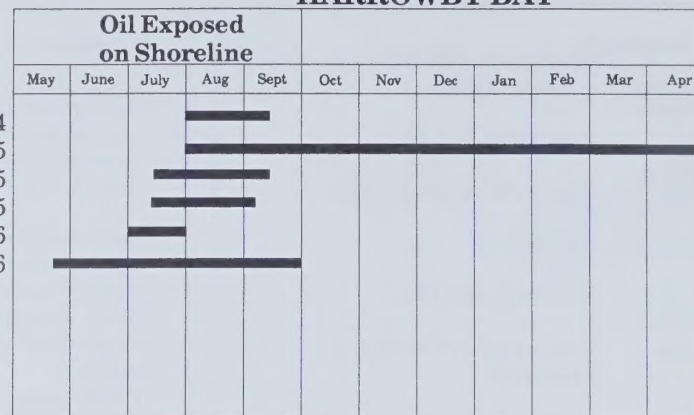
Fish

Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

R 64
R 65
DL 64,65
Ge 65
Ca 64,65,66
F 64, 65, 66



Environmental Description:

R 64 A fishing camp is often established at Ikpisugyuk Point during August and part of September.

R 65 North Star Harbour area is a site of historic importance and remains an important resource harvesting area. A family from Tuktoyaktuk spends some winters in this area (16).

DL 64, 65 From mid July to early to mid September, thousands of diving ducks stage and moult in the sheltered waters at Maitland Point, Ikpisugyuk Bay and Harrowby Bay (3).
Ge 65 From mid to late July to early September, thousands to tens of thousands of geese moult, stage and feed in the Harrowby Bay-Old River Horton River Channel area (3, 17).

Ca 64, 65, 66 A significant portion of the Bluenose caribou herd may use nearshore areas on the east side of Liverpool Bay to escape from flies during July (40).

F 64, 65, 66 Harrowby Bay may provide summer feeding habitat for fish (grayling, pike and sucker) from the Horton River (2). There is virtually no published information regarding the use of these coastal areas by fish. Anadromous species from the Anderson River may feed in these coastal areas during the summer (2).

OPERATIONAL MAP 25 Harrowby Bay SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

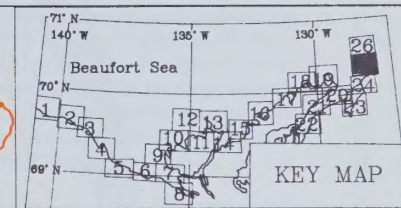
0 1 2 3 4 5

Mercator Projection

KM

1:150,000 at 70° 00'N

0 1 2 3 4 nmi



AREA 66

Ca66

F66

128° 00' W

Neil L

CY PECK INLET

LIVERPOOL
BAY

70° 15' N

HARROWBY BAY

AREA 65

R65

North Star
Harbour

F65

DL65

Ca65

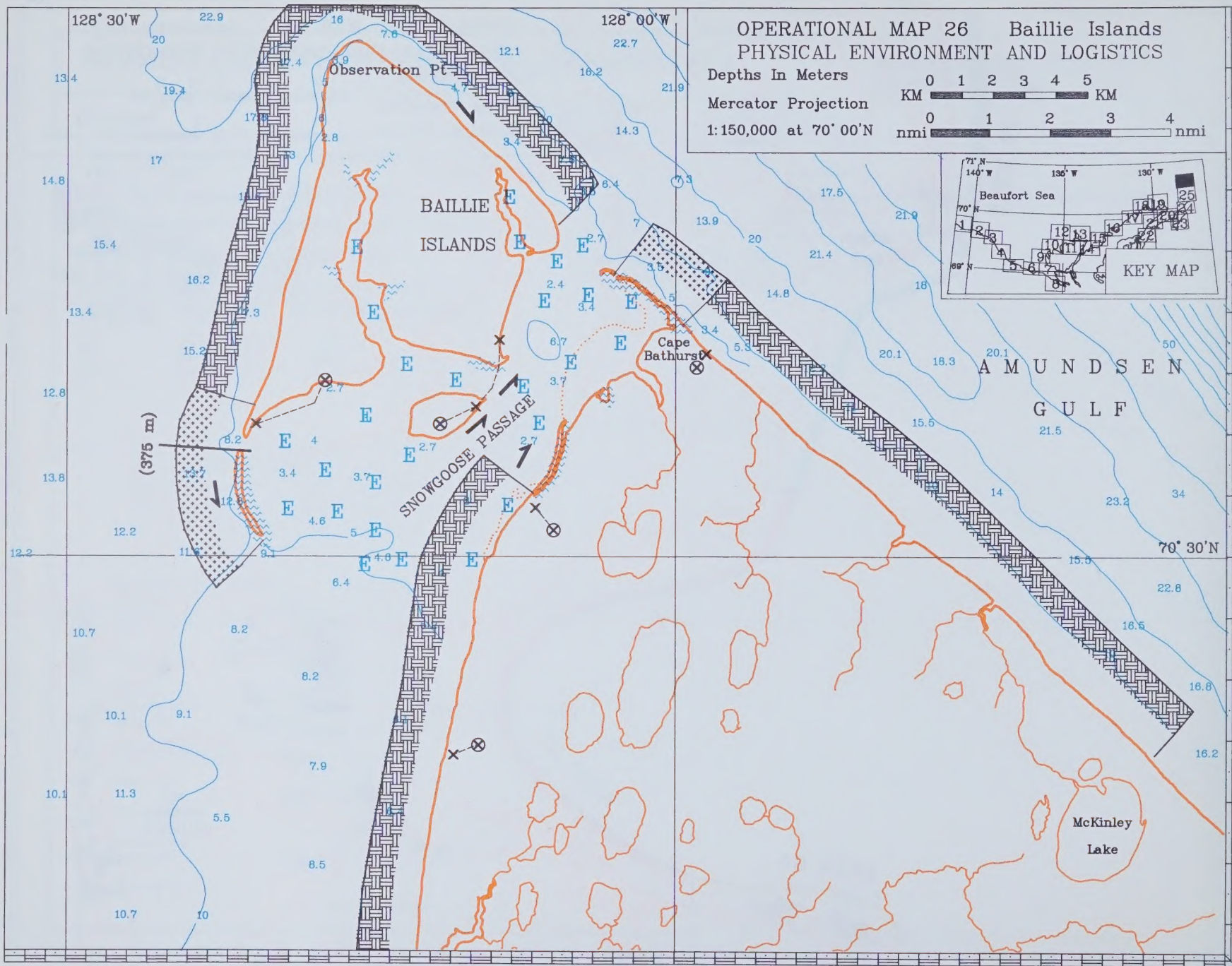
OLD
HORTON
CHANNEL

Ge65

AREA 64

Ca64

F64



PHYSICAL ENVIRONMENT AND LOGISTICS

OPERATIONAL MAP 26 BAILLIE ISLANDS

Legend

	Tundra Cliffs
	Inundated Tundra
	Barrier Beaches & Spits
	Deltas
	Estuaries and Bays
	Net Longshore Sediment Transport
	Areas Inundated During Positive Storm Surges
	Low Water Line
	Artificial Islands
	Anchorage
	Shore Access (Barge Offloading)
	Airstrip suitable for STOL
	Airstrip suitable for F27, HS748
	Airstrip suitable for Hercules
	Ice Runways (Winter Only)
	Inlet Width (m)
	Potential Debris Storage - Temporary
	Potential Disposal Site - Permanent
	Summer Access (Disposal Sites)
	Winter Access (Disposal Sites)

Nearest Airstrip - Nicholson Island, Map 20

Hydrographic Chart - 7664

Video Tapes - Dome 19, 20

Access:

A radar reflector beacon with an elevation of 15.2 m is situated on Observation Point, large Baillie Island. Observation Point has been picked up on radar at a distance of 19 km. Gradients off the eastern and western sides of the larger Baillie Island are steep: the 11.0 m contour occurs 1.3 km from the eastern side, and the 14.6 m contour lies 800 m off the western side. The average depth is 3.4 m between the islands and the mainland. The least depth, 2.7 m, lies in the northern entrance of Snowgoose Passage. Depths are likely to be less than charted due to the considerable erosion and subsequent silting that is occurring. The normal tidal variation at Baillie Islands is 0.3 m.

A current flows SE at about 1 knot off the west side of Baillie Islands, but along the east side it flows NW from the Amundsen Gulf at about 2.5 knots. A large eddy, circling in a clockwise direction, extends about 5 km north of Observation Point where the two above-mentioned currents meet.

Vessels can anchor behind the main Baillie Island and the sand spit projecting from Cape Bathurst. Anchorage in 2.1 m of water is available 90 m offshore in the shelter of the hook at the northwest end of the sand spit. Usual entrance into Snowgoose Passage is from the southwest. Entrance from eastwards at a depth of 2.7 m must be made around the northern end of the sand spit, extending north from Cape Bathurst. Note that the shape, position, and continuity of this spit can change as a result of a single storm. Vessels drawing about 2 m can find shelter from winds in any direction by shifting anchorage. Vessels drawing 1 m or less can gain safe shelter inside the 5 km long inlet at the main Baillie Island.

Countermeasures:

Conventional offshore countermeasures, dispersion or containment for recovery or in-situ burning are recommended subject to weather and logistical limitations. Dispersant use is ecologically justified offshore and within the coastal zone when oil threatens waterfowl concentrations or waterfowl habitats.

Snowgoose Passage and the sheltered waters behind Baillie Islands should be protected; incoming oil slicks may be diverted to the spit on the southwest corner of main Baillie Island and to the sand beaches south of the island. The channel between the spit and main island should also be sealed. Should oil enter the sheltered area behind the main island, inter-island channels and the entrance to the large bay may be sealed as necessary to limit the extent of shoreline contamination. If large numbers of flightless diving ducks are present, helicopters and boats should be used to herd birds away from oil contaminated areas.

Exposed cliffs on the seaward coast of main Baillie Island may not require active cleaning depending on the degree of contamination. Potential disposal sites, with winter access, are identified for the southwest Baillie sandspit and for the sand beaches southwest of Cape Bathurst. Barge access for the delivery of cleanup machinery is possible at most locations.

OPERATIONAL MAP 26

BAILLIE ISLANDS

Shoreline Environmental Sensitivity*

■ High Sensitivity Ranking > 68.70
■ Moderate Sensitivity Ranking 35.10 - 68.70
■ Low Sensitivity Ranking < 35.10

* See Appendix A. See Regional Maps for Offshore Sensitivity

Area No.	Area Name	Sensitivity Ranking
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67	Snowgoose Passage	59.35
68	Baillie Islands	23.50
69	Cape Bathurst	20.80

- Archaeological Site
- Heritage Site - locally identified
- ◆ Major Resource Harvesting Camp
- ▲ Other Resource Harvesting Camp
- National or Territorial Park

Resource Harvesting Areas

Highly Important R

Important R

Birds

Diving Ducks & Loons DL

Dabbling Ducks DD

Geese Ge

Swans Sw

Shorebirds & Cranes SC

Seabirds Se

Mammals

 White Whale WW Bowhead Whale Bh Polar Bear PB Ringed Seal RS Bearded Seal BS Arctic Fox AF

Reindeer Re or
Caribou Ca

Fish



Anadromous Fish & Pacific Herring F

Site Specific

Occurrence of Species and Resource Use

DL 67
Ca 66,67,69
F 66, 67
F 68, 69

Oil Exposed on Shoreline

[illegible]

Environmental Description:

DL 67 From mid July to early August, thousands of diving ducks moult and feed in the Snowgoose Passage area south of Baillie Islands (3).

Ca 66, 67, 69 A significant portion of the Bluenose caribou herd may use nearshore areas around Cape Bathurst to escape from flies during July (40).

F 66, 67 Pacific herring spawn, rear and overwinter in these areas. Arctic cisco and least cisco use the areas during summer (2, 39).

F 68, 69 There is limited information regarding the fish species and their distribution in these areas (2).

OPERATIONAL MAP 26 Baillie Islands

SHORELINE ENVIRONMENTAL SENSITIVITY

Depths In Meters

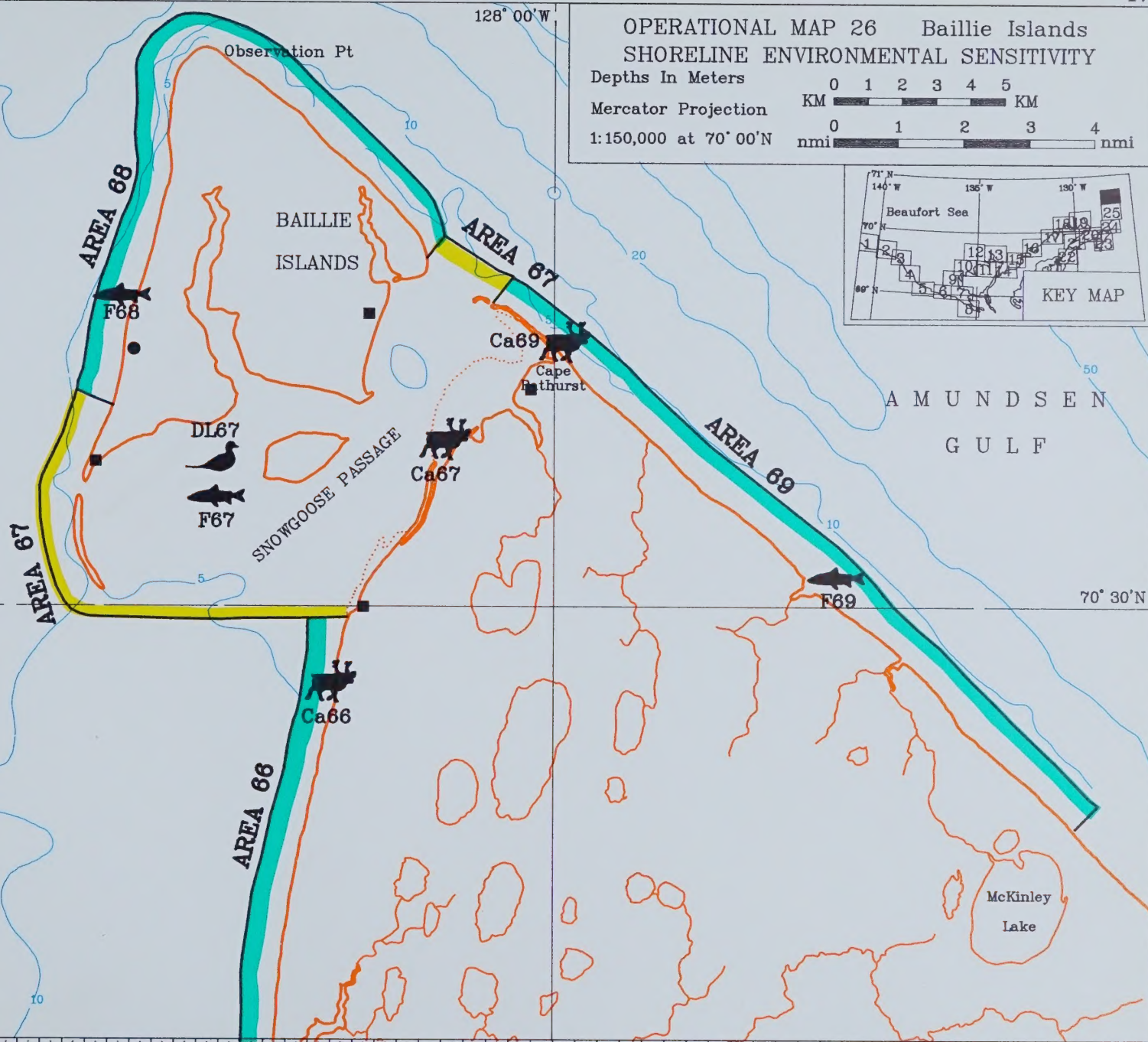
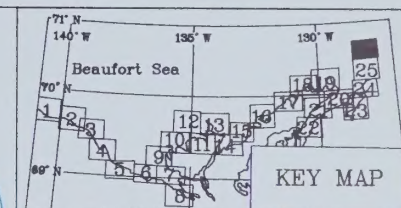
0 1 2 3 4 5

Mercator Projection

KM

1:150,000 at 70° 00'N

0 1 2 3 4 nmi



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APPENDIX A. ENVIRONMENTAL SENSITIVITY RANKING SYSTEM

1.0 INTRODUCTION

The environmental sensitivity ranking system used in the atlas was developed to describe the relative sensitivity of shoreline and offshore areas of the Beaufort Sea to effects of oil spills. The ranking of particular areas according to environmental sensitivity criteria is necessary because there is a limited amount of equipment and manpower available to respond to oil spills. This atlas is intended to be one tool that will be used to decide where to deploy the available resources at the time of a spill.

The following description of the environmental sensitivity ranking system includes a complete discussion of the rationale and assumptions involved in the development of the system and the limitations of its use. It is essential that users of the atlas understand this system prior to reviewing or using the environmental sensitivity maps.

The environmental sensitivity ranking system builds on a scheme that was developed previously for the Beaufort Sea by Worbets (1979). Although Worbets' scheme has been modified to meet the specific objectives of this project, its use has several distinct advantages. Firstly, the ranking system incorporates and weighs environmental components that are important to the sensitivity evaluation, and results in a single numerical value to describe the relative sensitivity of an area. Secondly, it allows scrutiny of the individual elements that determine the sensitivity of each area. The individual elements that contribute to a given sensitivity ranking are critical considerations in a decision process regarding cleanup and protection strategies. Finally, Worbets' (1979) manual has been the primary resource document for shoreline oil spill protection and cleanup since its publication and, therefore, many users of this atlas will already be familiar with the sensitivity ranking system.

2.0 OVERVIEW

The sensitivity ranking system is based on a total of 20 environmental elements ranked within three categories: (1) human

use sensitivity; (2) biological sensitivity; and (3) shore zone oil residence category or marine oil residence category. The marine oil residence category was developed specifically for this atlas to allow the overall sensitivity of offshore areas to be determined. This category effectively parallels the shore zone oil residence category that was developed to determine the sensitivity of coastal areas. The above three categories were assigned a Weighting Factor (WF) that quantitatively represents the relative importance of each category within the entire ranking system (Table A1). The Weighting Factors range from 1.5 to 2.00.

Table A1
Relative Importance of Categories in the
Environmental Sensitivity Ranking System

Category	Weighting Factor (WF)
Human Use Sensitivity	2.00*
Biological Sensitivity	1.75*
Shore Zone Oil Residence	1.50*
Marine Oil Residence	1.50+

*Worbets (1979)

+New category developed for this atlas

Human use sensitivity received the highest Weighting Factor of 2.00 because the protection of human life, life style and property is considered the highest priority during an emergency response (Worbets 1979). The biological sensitivity category was assigned a Weighting Factor of 1.75 to reflect the importance of these resources. The marine and shore zone oil residence categories received a lower Weighting Factor (1.50) and relate to the persistence of oil in the environment.

Selection of specific environmental elements within each of the categories was necessary to develop a relatively simple ranking system that still adequately considered the complex environment of the Beaufort Sea. The rationale for the inclusion and ranking of the

individual elements was based on:

1. a review of the literature regarding the sensitivity and vulnerability of resources to the effects of oil;
2. those resources that were identified through the Beaufort Environmental Monitoring Project (Indian and Northern Affairs Canada and Environment Canada 1985) as being of the highest profile in the region;
3. research on the fate and persistence of oil in cold, ice-infested water and in northern coastal environments;
4. results of a workshop conducted in Inuvik on 14 January 1987 regarding the use of the land and renewable resources by residents of the region; and
5. the consensus of the study team and Steering Committee members regarding the relative ranking of each environmental component or element.

A description of the rationale used in the selection and ranking of the individual elements within each category is provided in Section 3.0.

The environmental elements within each category were given an Assigned Value (AV) between 1 and 10, where 10 represents the component or element most sensitive to oil. For example, the habitat of rare or endangered birds is the most sensitive in the biological category, while estuaries and bays with low wave exposure are the most sensitive in the shore zone oil residence category.

The sensitivity of a specific shoreline or offshore area to oil was determined by reviewing the 20 elements, identifying which ones apply to the area, and then summing the Assigned Values (AV) multiplied by their Weighting Factor (WF) for each of those elements. For example, a stretch of shoreline may (1) have tundra cliffs; (2) support a significant portion of the population of rare or endangered birds; and (3) be within a territorial park. For each of these three elements, the Assigned Value is multiplied by the Weighting Factor of its category to produce a Priority Index (PI) for that element (i.e., $AV \times WF = PI$). The priority indices of all elements that apply to the area are then summed to produce a single number that represents the

sensitivity of that particular area to oil (Worbets, 1979). The environmental sensitivity ranking scheme follows Worbets (1979) and can be summarized as follows:

$$S = \sum PI$$

where $AV \times WF = PI$
 S = sensitivity of a specific area to oil
 PI = priority index for each element
 AV = assigned value of element
 WF = weighting factor common to each element within a category

3.0 CATEGORIES IN THE SENSITIVITY RANKING SYSTEM

The following sections describe in detail the human use sensitivity, biological sensitivity, shore zone oil residence and marine oil residence categories.

3.1 Human Use Sensitivity Category

The human use sensitivity category was intended to focus the decision-making process regarding priorities for oil spill cleanup and protection on shoreline and offshore areas that are important for human activities and cultural resources and, therefore, are sensitive to the effects of an oil spill. This category accounts for past and present human use of the land and marine resources of the Beaufort Sea region, and is based on historical and recent information regarding resource harvesting, important archaeological and heritage sites and national and territorial parks.

3.1.1 Selection of Human Use Elements

The initial selection of the elements in this category was based on those resources that were considered sensitive by Worbets (1979). Although substantial revisions to this list were anticipated since the human use category had not been examined by resource users in the region, it served as a good starting point for the review of information. The initial list of the human use elements included:

- land use
- community of Tuktoyaktuk

- archaeological sites
- parks, sanctuaries and reserves
- proposed parks
- IBP sites
- natural areas of Canadian significance (NACS)
- natural sites of Canadian significance (NSCS)
- native land claims

The final selection of elements for the human use category was based on the following criteria: (1) the element represented a distinct human use that could be affected in the event of a marine oil spill and (2) the element was highly valued by regional residents or had a protected status.

Land and Resource Use

Use of the land and renewable resources by residents of the region is an important element of the human use sensitivity category. However, there are currently no reliable measures of the number of people using particular areas, the harvesting success at various sites, or the values attached to the harvest of different resources by resource users (economic, dietary and cultural). Therefore, some of the conclusions that were drawn from published sources on the most important areas for resource harvesting were circulated to representatives of a number of resource-user groups and government agencies in an attempt to obtain more complete and up-to-date information. It then became apparent that a meeting with the residents of various communities within the Beaufort region was necessary to obtain information required for this project component.

A one-day workshop was held in Inuvik to identify the coastal areas of most importance to residents of the region, and to determine the activities that may be affected by a marine oil spill. While particular emphasis was placed on land values associated with renewable resource harvesting, cultural and social values as well as health concerns were also addressed. A total of 12 residents from the region attended the workshop. The majority of these participants were selected by the Hunters and Trappers Association in Aklavik, Inuvik and Tuktoyaktuk. These individuals were active hunters or trappers that were able to identify harvesting areas used by members

of their respective communities. In addition, a number of women who take their families to fishing and whaling camps each summer or who are knowledgeable about their community's harvesting activities on the coast also participated in the workshop. The following is a list of the workshop participants.

Participants at Inuvik Workshop January 14, 1987

Tuktoyaktuk

Ada Carpenter
Helen Gruben
Jimmy Jacobson
Frank Pokiak
Fred Wolki

Aklavik

Tom Arey
Andy Kayotuk

Inuvik

Renie Arey (Aklavik/Inuvik)
Alex Aviugana
Emma Dick
David Roland

Old Crow

George Vittrekwa

Resource People

Roger Allen, COPE
Tom Nesbitt, COPE
Dave Sullivan, DIZ Society
Ian Ross, Department of Renewable Resources
David Dickins, Study Team
Diane Erickson, Study Team

The workshop participants identified on maps those areas that are most important for resource harvesting (i.e., for those species included within the atlas, see Section 3.2.1) and the specific locations of harvesting camps. Information on the time of harvest and whether the identified areas were used each year was also obtained in the

workshop. The group also identified areas that they considered the most important in terms of exposure of people to an oil spill (i.e., those areas most heavily used or populated). Sites or areas along the shoreline that have the greatest cultural or historic significance to local residents were also identified.

On the basis of the different identified land uses, the participants then selected areas which they believed to be the most critical to protect in the event of a marine oil spill. It was concluded that the areas most sensitive to the effects of a spill were also those areas that had already been identified as the most important in terms of exposure of people to an oil spill.

On the basis of information obtained from the workshop, the project team ranked each of the selected areas into three major categories:

1. areas of greatest importance to regional residents;
2. areas highly important to regional residents; and
3. areas important to regional residents.

Community of Tuktoyaktuk

The community of Tuktoyaktuk was identified as a separate element within the human use category. The area had been selected in the workshop as one of the areas of greatest importance to regional residents. However, it was concluded that its importance as a human settlement warranted additional recognition in this category.

Archaeological Sites

Site-specific information on archaeological sites was obtained from the Archaeological Survey of Canada inventory. This is the most up-to-date inventory of historic and prehistoric sites in the Yukon and Northwest Territories. Although there are areas along the coast that have not yet been surveyed as extensively as others, the inventory likely includes about 90 percent of the surficial archaeological sites that exist in the area (J. Cinq-Mars, Archaeological Survey of Canada, pers. comm.).

It is noteworthy that some of the archaeological sites only represent isolated finds, where an area of historical significance has been identified but the finds have been removed. In addition, some of the sites that have been found along the shoreline may not currently exist due to the high natural erosion rate along portions of the NWT and Yukon coast (J. Cinq-Mars, Archaeological Survey of Canada, pers. comm.). In the event of a marine oil spill, it will be necessary for response personnel to contact the Archaeological Survey to obtain information on the contents and status of the archaeological sites so that their relative importance can be determined. To protect these sites from being exploited, this information was not included in the atlas.

Parks, Sanctuaries and Reserves

Information on special status areas within the Yukon and Northwest Territories was reviewed to determine existing national and territorial parks, sanctuaries and reserves in the study area (Environment Canada 1982; INAC 1984; Larson 1985; Allison and Peterson 1985). The following areas were identified during this review:

- Northern Yukon National Park
- Herschel Island Territorial Park
- Anderson River Bird Sanctuary
- Kendall Island Bird Sanctuary
- Reindeer Grazing Reserve
- Pingo Canadian Landmark Site

Although it was agreed that areas designated and protected as parks and landmark sites warranted consideration in the sensitivity ranking process, the study team members concluded that sanctuaries and reserves be removed from the human use category. Because the most important bird species and the reindeer herd were already included in the biological sensitivity category, inclusion of these resources in the human use category would cause areas that lie within the sanctuaries and reserve to receive a higher overall sensitivity ranking than warranted. Critical habitats used by birds for staging, moulting, breeding and brood-rearing have been identified during the course of several years of studies by the Canadian Wildlife Service, and were considered in the evaluation of the biological sensitivity. Consequently, other areas within the sanctuaries that are

not used by birds on a regular basis or in significant numbers were not considered as sensitive to the effects of oil spills (see Section 3.2). Similarly, the reindeer grazing reserve encompasses a very large area that extends from the Mackenzie Delta to Cape Dalhousie, although only specific areas along the coast are used as summer range. These areas have been identified and taken into consideration within the biological category.

Proposed Parks, IBP Sites and NASC/NSCS

Through various scientific research initiatives, the International Biological Programme (IBP) generated extensive data regarding "significant areas" in the North. Although the IBP sites established in the 1970's were originally identified as areas for protection, there has been no legislation introduced to protect these sites. The major benefit of the programme has been the identification of significant areas, which has subsequently allowed various agencies to designate special areas for protective status (M. McComb, Parks Canada, pers. comm.). Some of these sites have been designated as sanctuaries or parks by Parks Canada and other government agencies, while others may be given some protected status in the future.

Three areas in the Beaufort Sea marine region have been identified as preliminary Natural Areas of Canadian Significance (NASC) by Parks Canada: (1) Yukon coast - Herschel Island; (2) Tuktoyaktuk - Liverpool Bay; and (3) Franklin Bay - Amundsen Gulf (outside the study area). Of these, only one will be considered a National Marine Park (M. McComb, Parks Canada, pers. comm.). In addition, a submarine pingo area 160 km north of Toker Point has been recommended as a Natural Site of Canadian Significance (NSCS), and could be declared a Canadian Landmark at some future date.

It was concluded that IBP sites and NASC/NSCS be eliminated from the human use sensitivity category because they do not currently have any designated or protective status. However, if this atlas is updated in the future, the status of such sites should be reviewed at that time.

Native Land Claims

Native land claims were recognized as special status areas and were considered for inclusion in the human use sensitivity category. However, it was agreed that land uses within these areas would be

adequately considered within the other elements of the human use category.

3.1.2 Ranking of Human Use Elements

Ranking of the elements within the human use sensitivity category involved an assessment of their sensitivity to the effects of oil spill events and consideration of the values attached by regional residents to their use of the land and marine resources relative to Assigned Values for parks and archaeological sites. The final ranking of the elements in this category is presented in Table A2.

Land and Resource Use

Resource harvesting activities may be affected both directly and indirectly by an oil spill. Areas where camps have been traditionally used for whaling, fishing and/or hunting are particularly sensitive because of the lack of alternative camp locations and concerns related to human health.

Areas of greatest importance to regional residents were defined as those that the workshop participants had identified as being the most critical to protect and, therefore, have received the highest ranking within the human use sensitivity category. In most cases, these areas contain major resource harvesting camps. Areas highly important to regional residents included those areas where harvesting activities are concentrated but are not in the immediate vicinity of a major camp. This element has been ranked as the next most sensitive element. Areas important to regional residents were defined as those areas where harvesting activities take place over a large region (such as caribou hunting on the Yukon coast) and/or those areas where a heritage site has been identified by members of communities within the region. These areas were considered less sensitive than other areas where resource harvesting occurs.

The Community of Tuktoyaktuk

The community of Tuktoyaktuk received the highest Assigned Value because shoreline areas are important to community residents (approximately 800 people) for a number of activities and oil contamination would adversely affect their use of these coastal areas.

Table A2
Human Use Sensitivity Category

Element	Assigned Value	Weighting Factor	Priority Index
1. Area of greatest importance to regional residents	10	2.00	20
2. Community of Tuktoyaktuk	10	2.00	20
3. Area highly important to regional residents	8	2.00	16
4. Area important to regional residents	6	2.00	12
5. Archaeological sites	5-6	2.00	10-12
6. Parks	4	2.00	8

Archaeological Sites

Ranking of archaeological sites was based on the potential for damage either directly by oil or indirectly due to cleanup activities. The Assigned Value for these sites ranges from 5.0 to 6.0, depending on the number of sites that exist within a specific area. When an area contains more than two archaeological sites, the Assigned Value was increased from 5.0 to 6.0. This was to ensure that areas that contain a greater number of archaeological sites would receive a higher Priority Index than those areas where only a few sites have been identified. Only those archaeological sites that are located along the shoreline in areas of inundation were included within the ranking.

There was no potential or justifiable means to rank archaeological sites relative to one another, since the cultural importance of each site has not been determined by the Archaeological Survey. However, those sites that were identified by regional residents as the most important heritage sites have been considered separately (see above) and have received a slightly higher ranking (i.e., Assigned Value of 6.0) when an area contains less than 3 federally identified sites. It should be noted that the "archaeological" and "heritage" sites were always ranked separately even though they may appear to be the same site. This was because the available information on site location is not exact.

Parks

Ranking of parks was also based on the potential for damage either directly by oil along the shoreline or by cleanup activities in response to a spill. National and territorial parks and Canadian landmarks received an Assigned Value of 4.0 in recognition of their protected status and importance to the people of Canada.

3.1.3 Limitations of the Human Use Category

Limitations of the human use category were largely due to the lack of information about human use of the Beaufort Sea region, the variable nature of land-use patterns and the process used to gather new information.

There have been few extensive studies of renewable resource harvesting in the Beaufort Sea region. The data that have been collected are out of date and, therefore, are of limited use for future planning. As patterns of land use are constantly changing, the areas used and the intensity of harvest activity are very difficult to predict from year to year (Canada, Department of the Environment, 1976).

The definition of "areas of importance to regional residents" relied on information provided by a selected group of residents at a one-day regional workshop. In addition to the time limitation, there was a potential for bias in the recording of information. The study team is confident that the group was a representative and knowledgeable one and that the establishment of a consensus within the whole group regarding the most important areas to protect is an important indicator of the reliability of the information.

It is important to note that the resource harvesting information identifies only selected areas and does not represent all harvesting areas or harvesting camps. The workshop participants were asked to identify only those areas which were most important and those activities which might be affected by a marine oil spill. Information about winter harvesting activities in shoreline areas, therefore, was not systematically gathered. The ranking of areas and the presentation of harvest information on the operational maps is restricted to important harvesting activities that occur between 20 May and 1 October.

3.2 Biological Sensitivity Category

3.2.1 Selection of Biological Resources

The biological sensitivity category is intended to focus the decision-making process regarding priorities for oil spill cleanup and protection on areas where there are large numbers of resources that are sensitive to the effects of oil. The following criteria were used to select the key resources for evaluation of biological sensitivity as a component of this project.

1. the known sensitivity of a species to effects of oil and its vulnerability to oil exposure;
2. the importance of a species to regional residents, scientists, government or the public; and
3. the rare or endangered status of a species.

On the basis of these criteria, birds, marine and terrestrial mammals and fish were selected as the key resources in the biological sensitivity category. Limiting the category to these three major groups was necessary to achieve a reasonably simple but justifiable ranking system.

The three criteria described above were also used to determine the most sensitive, vulnerable and important species in each major category of biological resources.

Birds

The selection of individual species of birds was complicated by the facts that: (1) a large number of species use habitats in the Beaufort Sea region and (2) virtually all birds are highly sensitive and vulnerable to the effects of oil. Therefore, six groups of birds were selected to represent the most important species that occur in the region. These groups are: (1) diving ducks and loons; (2) dabbling ducks; (3) geese; (4) swans; (5) shorebirds and crane; and (6) seabirds. Table A3 (following page) lists the important species in each of these groups.

Table A3
Important Bird Species in the Southeast Beaufort Sea

1. Diving Ducks and Loons:	oldsquaw king eider common eider surf scoter white-winged scoter greater scaup lesser scaup red-breasted merganser red-throated loon Pacific loon yellow-billed loon
2. Dabbling Ducks:	pintail
3. Geese:	black brant lesser snow goose greater white-fronted goose Canada goose
4. Swan:	tundra swan
5. Shorebirds and Crane:	sandpipers (semi-palmated, stilt, sanderling, dunlin) plovers (black-bellied, lesser golden) phalaropes (red, red-necked) curlews (Eskimo*, whimbrel) sandhill crane
6. Seabirds:	gulls (glaucous, Sabine's) Arctic tern auks (black guillemot**)

*The Eskimo curlew is a rare and endangered species (Gallop et al. 1986). The status of this species in the Northwest Territories is uncertain; the most recent confirmed sightings were during summer 1980 in the Anderson River delta (Gallop et al. 1986).

**Following the precedent set by Worbets (1979), this species is considered to be rare and endangered for the present analysis because of their very restricted breeding distribution in the Beaufort Sea.

Marine and Terrestrial Mammals

White whales, ringed seals, bearded seals and polar bears were included in the biological sensitivity category because of their importance to regional residents as harvested resources. Bowhead whales were included because of their endangered status. Three terrestrial mammals, reindeer, caribou and Arctic fox, were also selected because of their importance to regional residents and their vulnerability to oil exposure in nearshore and shoreline habitats and, in the case of the latter species, on the landfast ice during winter.

Fish

The sensitivity of arctic fish species to petroleum hydrocarbons has not been well documented from either laboratory research or studies conducted following actual spills. However, some investigators have recently suggested that the sensitivity of arctic species may be similar to that of similar species in temperate waters (e.g., Carls and Korn, in press, cited in Rice 1985). Rice (1985) concludes that arctic fish populations, particularly in inshore areas, may be more vulnerable than fish stocks from other habitats because the shallow, cold waters of the Beaufort Sea would tend to increase the persistence of toxic aromatic hydrocarbons that enter the water. In addition, fish that are stressed by other environmental conditions (e.g., fluctuations in temperature, salinity or food abundance) may be more sensitive to the effects of oil exposure than other fish that are not stressed.

On the basis of this information and the fact that many of the anadromous species are harvested by residents of the region, Arctic and least cisco, lake and broad whitefish and Arctic char were included within the biological sensitivity category. These species preferentially use shallow shoreline areas for feeding and migration during the summer. During this period, there may be natural stresses on fish populations due to fluctuations in temperature and salinity in coastal habitats. Pacific herring was also included because it spawns in shallow shoreline areas and its eggs and larvae are very sensitive

and vulnerable to the effects of oil (Trudel 1985a). Although Pacific herring are not harvested at the present time, there are ongoing investigations of the Beaufort Sea stock to determine the potential for a commercial harvest of this species in the area.

3.2.2 Sensitivity of Biological Resources to Oil

Each of the key resources in the biological sensitivity category were ranked according to their relative sensitivity and vulnerability to oil spills. The sensitivity ranking was based on three characteristics of each species or group: (1) the known toxic effects of petroleum hydrocarbons on individuals; (2) the probability of potential contact of the population with oil in the environment (vulnerability); and (3) the potential for the population to recover from adverse effects of oil exposure, based on the known toxic effects and the assumption that a "significant" proportion of the population would encounter oil.

Information sources used to determine the toxicity and vulnerability of each resource included a summary of over 100 oil spill case histories (Duval et al. 1981), recent reviews of the effects and behaviour of oil in the arctic environment (Engelhardt, ed. 1985, Duval, ed. 1985), information on species activities and habitat preferences in the Beaufort region summarized in Dome et al. (1982), and life history information available throughout the open literature. To determine the anticipated period for a population to recover from effects of oil spills, the following information was considered: (1) the type of physical or toxic effect (e.g. lethal or sublethal); (2) the reproductive potential, population dynamics and the food and habitat requirements of the species (i.e., does the species reproduce in alternate years or less frequently and have limited or specific habitat requirements); (3) the potential for recovery through immigration (i.e., are there individuals in adjacent areas that could immigrate and has immigration of the species been documented in the past?); and (4) the potential for differential effects on specific age classes.

Table A4 summarizes the relative sensitivity of each biological resource to oil spills based on toxicity to oil, vulnerability to oil exposure, and the anticipated period of recovery. Because the quality of the data available to describe these characteristics varied among resources, professional judgements and assumptions were generally necessary in ranking the resources. It is important to note that professional judgement became increasingly necessary as the

amount of relevant information decreased. Some of the major judgements and assumptions are that: (1) the toxicity, vulnerability and recovery of species within a group was comparable; (2) the sensitivity of different groups (i.e., mammals versus fish) was comparable; and (3) the sensitivity of arctic species is similar to that of some temperate species. Although the effect of judgements and assumptions on the overall sensitivity rankings has not been indicated in Table A4 (following page), the level of confidence associated with each evaluation has been identified.

Marine birds are often the most visibly affected group following marine oil spills. This situation is likely to be more pronounced in cold environments where both the sensitivity and vulnerability of marine birds to oil are expected to be high due to the combined effects of low temperatures and the presence of ice (Duval, ed. 1985). Oil contaminated birds may sink or drown, but loss of insulation is usually the primary cause of death in cold climates (Trudel 1985b). Oiled birds may ingest oil while preening and birds may also ingest oil by eating oil contaminated food. Toxic effects of ingested oil have also been implicated in the deaths of birds during oil spills (Duval et al. 1981). Historical data from past spills clearly indicates that auks and seaducks are more vulnerable to oiling than are other species such as gulls, terns and certain waterfowl (Duval et al. 1981). Birds that dive to feed or that are highly gregarious are particularly vulnerable to oil, while species that are widely distributed or that spend a significant proportion of time in terrestrial or backshore habitats are less vulnerable. The relative sensitivity of the groups of birds selected for the atlas is shown on Table A4 and is based on the above information and consideration of the rare or endangered status of some species.

Contamination or mortality of seals has been documented following several past oil spills (Duval et al. 1981). Seals are most vulnerable to oil exposure during winter and spring, when they may contact oil within the landfast ice at breathing holes or on the ice surface in melt pools when they are hauled out. Seal populations would likely recover in a short period since large fluctuations in the size of the population of both ringed and bearded seals have occurred naturally in this region.

Although there are no documented cases where death of polar bears has resulted from exposure to oil in their natural environment (Duval, ed. 1985), mortality of bears has resulted from oil exposure

Table A4
Relative Sensitivity of Key Biological Resources
to the Effects of Oil+

Species/ Group	Oil Toxic/ Physical Effects	Vulnerability	Anticipated Recovery Period	Relative Sensitivity
Eskimo curlew	Lethal (1)*	Extremely High (1)	Long to no recovery (1)	Increasing Sensitivity ↑
Black guillemot	Lethal (1)	High (1)	Long (1)	
Diving ducks and loons	Lethal (1)	Extremely High (1)	Long-Short (2)	
Shorebirds, gulls and brant	Lethal (1)	High (1)	Short (2)	
Dabbling ducks, swans and geese	Lethal (1)	Moderate - High (1)	Short (2)	
Bearded and ringed seals	Lethal- Sublethal (1)	High- Moderate (1)	Short (2)	
Polar bears	Lethal- Sublethal (2)	Moderate (1)	Short (3)	
Fish nearshore	Lethal- Sublethal (1)	Moderate (1)	Short (2)	
Fish offshore	Lethal- Sublethal (1)	Low (1)	Short (1)	
Bowhead whales	Sublethal (3)	Moderate (2)	Long-Short (3)	
White whales	Sublethal (3)	Moderate (2)	Moderate- Short (3)	
Arctic fox	Sublethal (3)	Low- Moderate (3)	Short (3)	
Caribou	Sublethal (3)	Low- Moderate (3)	Short (3)	
Reindeer	Sublethal (3)	Very Low** (1)	Short (3)	

+Sources: Duval et al. (1981); Dome et al. (1982); Engelhardt, ed. (1985); Duval, ed. (1985)

*(1) Level of confidence based on available data: 1 = High; 2 = Moderate and 3 = Low.

**The reindeer herd can be moved within 10 hours if an area is threatened by an oil spill (D. Billingsley, Co-owner of the Reindeer Herd, pers. comm.).

and ingestion during field experiments (Oritsland et al. 1981 cited in Engelhardt, ed. 1985). Polar bears are vulnerable to oil contact when they swim and hunt for seals in leads where oil may become concentrated. The period for recovery of polar bear populations affected by a spill would also likely be relatively short because the Beaufort Sea population is dispersed along the Canadian and Alaskan Beaufort Sea coast (Stirling et al. 1981b), and this would maximize recruitment rates.

Fish in nearshore habitats are more vulnerable to the effects of oil spills than fish in offshore areas. Mortality of significant numbers of adult fish has only been documented when spills have occurred in confined areas such as estuaries, mariculture pens or lagoons (Duval et al. 1981). Mortality or sublethal effects of oil on large numbers of adult pelagic fish in offshore habitats are not likely to occur because of the rapid dilution and dispersal of oil in such high-energy areas. Fish in nearshore habitats are more vulnerable and a range of sublethal effects are possible such as uptake of hydrocarbons, physiological disorders and tissue aberrations (Duval, ed. 1985). These effects are most likely to occur if oil contaminates nearshore benthic sediments or is slowly released from substrates in shoreline areas. The recovery time for nearshore fish populations following any losses associated with oil spills is uncertain, primarily due to the potentially longer period of chronic oil exposure (Duval et al. 1981).

Fish larvae are particularly sensitive to oil contact and sublethal effects can occur at relatively low oil concentrations (0.1 to 1.0 mg/L; Moore & Dwyer 1974, cited in Rice 1985). Fish eggs are usually less sensitive than larvae to oil exposure, but are generally more sensitive than are the adult stages (Rice 1985). Although oil may be lethal to eggs and larvae, fish populations that are affected by the loss of these stages would recover very quickly because of the combined high reproductive and recruitment potentials of most fish populations. There are high natural mortality rates of these life history stages and a relatively large proportion of progeny could be lost without affecting year-class strength (Rice 1985).

Mortality of whales has not been reported following past oil spills (Duval et al. 1981). However, it is possible that mortality

of whales could occur if whales were trapped in leads or enclosed bays and oil was simultaneously present in these areas (Duval, ed. 1985). The western Arctic population of bowhead whales would probably require a long period to recover if there was a significant reduction in the number of animals in the population. The western Arctic population has not yet recovered from the effects of the commercial harvest that was discontinued in 1914 (Breiwick et al. 1981), although the continued low level subsistence harvest in Alaska may have increased the recovery time. There is little or no opportunity for immigration of bowheads from adjacent areas.

Although lethal effects of oil on white whales have not been reported in the literature, mortality could occur if whales were concentrated in a lead or confined bay containing substantial amounts of oil (Duval, ed. 1985). It is possible that immigration of individuals from other white whale populations wintering in the Bering Sea would occur (Braham et al. 1984), and this would decrease the period required for the population to recover from any losses associated with an oil spill.

There are no available data on which to base an assessment of the potential effects of oil on Arctic fox, caribou or reindeer populations. Arctic foxes could encounter oil along shorelines and offshore on the landfast ice, particularly if they are attracted to sites where polar bears have killed oil-contaminated seals. Reindeer and caribou congregate in nearshore areas during the summer to avoid insects and to feed, and could be exposed to oil in these coastal habitats. However, as indicated earlier, the reindeer herd could be moved within 10 hours if there was a threat of oil contact (D. Billingsley, pers. comm.). Due to the ability to move reindeer out of an oil-threatened area and the probable minor sublethal effects of oil exposure on these mammals, they were expected to be the least sensitive group in the biological resource category.

3.2.3 Rationale for Biological Sensitivity Category

The biological sensitivity category is predicated on the assumption that the effects of an oil spill will be greatest if a "significant" proportion of the regional (Beaufort Sea or western Arctic) population is affected. The proportion of a population that would be considered "significant" has been determined independently for each resource group or species because of the substantial differences in confidence levels regarding the size of specific populations and because of

differences in reproductive capabilities. Considerations during the determination of a "significant" proportion of a given population included the type of potential effects and the anticipated period of recovery for that population following losses resulting from oil spills. The criteria and data used to determine the proportion of the population of each group that would be considered "significant" for purposes of this sensitivity analysis are described below.

Table A5 presents the final biological sensitivity rankings for each of the resources included in this category. The rationale for the Assigned Values is described below. It is important to emphasize that the Assigned Values (1-10) represent a judgement by the study team, based on: (1) the relative sensitivity and vulnerability of each species or group of species to oil spills; (2) the relative importance of the species or group of species in the region; (3) the status of the population; and (4) consideration of uncertainties regarding evaluations of the toxic and physical effects of oil and the anticipated recovery periods included in Table A4. Consequently the ranking of resources presented in Table A5 differs from that in Table A4, because the ranking in the latter was based primarily on the sensitivity and vulnerability of these resources to the effects of oil.

Table A5
Biological Sensitivity Category

Sensitivity Element		Assigned Value	Weighting Factor	Priority Index
1.	A significant proportion of the regional population of black guillemots or Eskimo curlews	10	1.75	17.50
2.	A significant proportion of the regional population of diving ducks and loons, seabirds, shorebirds or brant	9	1.75	15.75
3.	A significant proportion of the regional population of dabbling ducks, swans or geese (other than brant)	8	1.75	14.00
4.	A significant proportion of the regional population of ringed or bearded seals, or polar bears, or bowhead whales	7	1.75	12.25
5.	A significant proportion of the regional population of white whales or nearshore fish habitat	6	1.75	10.50
6.	Offshore fish habitat	5	1.75	8.75
7.	A significant proportion of the regional population of Arctic fox or caribou herd	4	1.75	7.00
8.	A significant proportion of the reindeer herd	3	1.75	5.25

Birds

Of the selected biological resources, the rare and endangered bird species were considered to be the most sensitive group. In addition to the fact that birds are extremely sensitive and vulnerable to oil, mortality of a relatively small number of individuals may lead to extinction of the species. Diving ducks, loons, shorebirds, gulls and brant were considered to be the next most sensitive groups because along the coast these species depend primarily on the marine environment for food and spend considerable time on the water surface or in shoreline habitats. It was concluded that dabbling ducks, swans and geese were the least sensitive bird groups because they use freshwater, wetland or tundra habitats along the coast to a much greater extent than marine areas and, therefore, are less vulnerable to effects of oil from a marine spill.

From spring through fall, birds are widely distributed and occur in varying densities and/or numbers along the entire Beaufort Sea coast. During these seasons, very few coastal areas are not inhabited to some degree by birds. McCormick et al. (1984) evaluated key habitats for birds in the Northwest Territories by assessing the percentage of the total population of a particular species or species group that used specific areas. Key areas were defined as those used by more than one percent of the population. It was not possible to employ this criterion to identify a significant proportion of a regional population for this study, because only coastal habitats along the Beaufort Sea coast have been evaluated in this project and reliable population estimates are not available for these areas.

The approach selected for this study involved a review of all available information on the

spatial and temporal distributions and abundance of birds along the Canadian Beaufort Sea coast from the Alaska-Yukon border to Cape Bathurst, and is similar to that employed by Smyth et al. (1986) in their recent atlas of key bird habitats in the region. Areas where birds are known to concentrate during migration, nesting, brood-rearing, staging and moulting periods were ranked according to the density or number (depending on the species and activity) of birds using the area. For most species, it was concluded that the highest 15-20 percent of these ranked areas represented a significant proportion of the regional population. Symth et al. (1986) state that "for those species which had reliable population estimates, each of the top 15-20 percent of the recorded values from surveys were usually equivalent in value to at least one percent of the Beaufort Sea population." Exceptions included the red-breasted merganser and glaucous gull, both of which are widely distributed and only concentrate in a few key areas in the region. In these cases, the highest 5-10 percent of the ranked areas were judged to represent areas where a significant proportion of the regional population was likely to occur. Pacific and red-throated loons are also widely distributed and occur in such low densities throughout nearshore areas of the Beaufort Sea that no high density or high abundance areas could be designated. Therefore, only those areas that have been clearly documented as being "high-use" areas based on research in the region were included in the sensitivity rankings.

Mammals

Seals and polar bears were judged to be the next most sensitive resources following birds due to the potential lethal effects of oil on these species and they have received an Assigned Value of 7. Bowhead whales were rated relatively high in biological sensitivity (also Assigned Value 7) because of the lack of available data to estimate the potential toxic or physical effects of oil, the endangered status of the population and the anticipated long period of recovery required for this population. White whales were judged to be less sensitive to oil spills than bowhead whales due to the anticipated shorter recovery period for this species. White whales received an Assigned Value of 6, also relatively high in the biological category, because of the uncertainty associated with the judgements regarding the potential physical and toxic effects of oil and the anticipated period of recovery. Caribou and Arctic fox are considered to be the next most sensitive groups of mammals and received an Assigned Value of 4.

Reindeer were expected to be the least sensitive group in the biological resource category because of the ability to move reindeer out of an oil-threatened area.

The information available to determine population sizes and the proportion of the population that represents a significant number of individuals varied for each selected mammal species and, therefore, is discussed below on a species-by-species basis.

Ringed and Bearded Seals

Only relative distribution and abundance data are available for ringed and bearded seals (Stirling et al. 1981a). The sizes of the Beaufort Sea populations of these species is presently unknown because there are no correction factors to apply to aerial counts to account for submerged animals not detected during aerial surveys. Therefore, 10 percent of the total number of animals sighted by Stirling et al. (1981a) between 1974 and 1979 was considered a significant proportion of the population for the biological sensitivity analysis.

Ten percent is considered a conservative estimate, since natural fluctuations of 50 percent have been observed in Beaufort Sea seal populations. During the period June 1974 to June 1975 the number of ringed seals in the Beaufort Sea declined by approximately 50%, but by June 1978 the population recovered to its previous level (Stirling et al. 1981a). Likewise, the bearded seal population declined by approximately 50 percent during the period June 1974 and June 1975 and returned to its original number by June 1978.

Polar Bears

Only relative distribution and abundance data are available for polar bears. Ten percent of the total number of polar bears sighted between 1971 and 1979 in the Beaufort Sea and Amundsen Gulf region by Stirling et al. (1981b) was judged to represent a significant proportion of the population.

Bowhead Whale

The size of the bowhead whale population that summers in the Beaufort Sea is approximately 4417 whales (IWC 1986). Three percent of this number was judged to be a significant proportion of the population

because of the probable long recovery period required for this species and the relatively small size of the population. Bowhead whales are known to travel through leads in the pack ice from Point Barrow to Banks Island during the spring (Marko and Fraker 1981), but this area was not included in the sensitivity rankings for bowhead whales because there is too little data available on the number of whales in this area.

White Whale

The Beaufort Sea population of white whales is estimated to contain at least 11,500 whales (Norton and Harwood 1986). Five percent of the population was judged to be a significant proportion for the biological sensitivity analysis because of the uncertainty of the period required for recovery of the population from a loss of a significant number of individuals. White whales have a low reproductive potential and it is uncertain if immigration of individuals from other populations would occur.

Arctic Fox

There is no available information on the size of the Arctic fox population in the Beaufort Sea region. This species may range over large areas when searching for food in the fall and winter (Eberhardt et al. 1982), but individuals have a small home range during the denning period and fox dens are reused each year (MacPherson 1969). Consequently, the Class 1 fox den habitat described by Nolan et al. (1973) was used to determine areas where a significant proportion of the population was likely to occur during some seasons.

Caribou

The Porcupine caribou herd uses the western portion of the study area and is considered to contain 150,000 individuals (Williams and Heard 1986). The Bluenose caribou herd uses areas in the eastern portion of the study area and contains approximately 60,000 to 80,000 individuals (Williams and Heard 1986). Five percent of either herd was judged to be a significant proportion for this analysis because of the lack of information regarding the effects of oil on this species and their relatively low reproductive potential. Immigration from other herds is unlikely.

Reindeer

The size of the reindeer herd is estimated to be 12,000 to 13,000 (D. Billingsley, pers. comm.). Areas considered to be significant are those along the coast that are intensively used during the summer (D. Billingsley, pers. comm.).

Fish

The size of fish populations in the Beaufort Sea is presently unknown, and information regarding fish use of shoreline and offshore areas between the Alaska-Yukon border and Cape Bathurst is inadequate to rank the importance of specific habitat areas. Because fish are ubiquitous and information on population size and habitat use could not be used to distinguish the relative importance of areas to fish, criteria regarding the vulnerability of fish in different areas was used in the sensitivity ranking. As indicated above, fish in nearshore areas are more vulnerable to oil, than fish in offshore areas. This criteria was used in the sensitivity ranking system to define two elements for fish; nearshore fish habitat, which was given an Assigned Value of 6 and offshore fish habitat, which was assigned a lower value (AV = 5). For purposes of this sensitivity analysis nearshore and offshore fish habitat are defined as:
Nearshore Fish Habitat - areas within 1 km of coastlines or areas further than 1 km from shore that are primarily less than 5 m deep;
Offshore Fish Habitat - areas further than 1 km from shore and greater than 5 m deep.

3.2.4 Application of the Biological Sensitivity Category

There was a difference in the application of sensitivity ranking elements for birds and mammals. Each mammal species was considered as a separate element. Therefore, the sensitivity ranking elements were summed for areas containing more than one mammal species. This additive system was not applied in the case of areas supporting significant proportions of more than one bird species or group of species. Although this ranking system may appear to under-rate the sensitivity of areas containing several bird species or groups, and over-rate areas where only a single species is found, this system was considered justified for the following reasons: (1) the groups within each element are based on sensitivity to oil rather than factors affecting their distribution; (2) over 100 species of birds occur in the

Beaufort Sea region compared to the limited number of mammal species; and (3) higher proportions of the regional populations (3-5 percent) were considered significant for mammals compared with only 1 percent in the case of birds.

3.3 Shore Zone Oil Residence Category

3.3.1 Selection of Shore Zone Oil Residence Elements

The shore zone oil residence category was developed to estimate the length of time required for natural processes to disperse the oil from the shoreline. It is emphasized that accurate estimates of oil residence can only be made at the time of a spill when important parameters such as oil type, spill volume and oil form at the shore zone are known. Consequently, the oil residence priority index represents only approximations that should be verified at the time of a spill.

Table A6 lists the principle factors that influence the persistence of oil stranded in the shore zone. Estimates of potential oil residence were based on: (1) a review of information on wave exposure, coastal morphology, substrate type and coastal stability of the Beaufort Sea coast; and (2) observations on the rate of natural cleaning of stranded oil under comparable environmental conditions (e.g., Owens 1973, 1977; Owens et al. 1982a, 1982b; Hayes et al. 1979; Gundlach and Hayes 1978).

Four coastal types were identified for the purpose of estimating oil residence. These represent combinations of morphology, substrate and coastal stability (tundra cliffs, inundated tundra, deltas and barrier islands and spits). A fifth coastal type was identified to represent areas of very low wave exposure (estuaries/embayments). Each type is briefly described in Table A7.

The assessment of potential oil residence involved consideration of the combined effects of wave exposure, coastal morphology, substrate type and coastal stability on unrefined crude oil from a marine oil spill stranded on shorelines. It also involved the assumption that oil stranded on the shoreline would remain there throughout the following winter. The estimated oil residence periods and assigned residence indices for each coastal type are presented in Table A8.

The shore zone oil residence category only applies as a residence indicator for the summer months. During the winter (October to late June) the landfast ice prevents new oil from reaching the shoreline. Oil already present on the shoreline at the onset of freeze-up in early October is essentially sealed in a frozen state until late May or early June of the following year when daily air temperatures once again rise above 0°C. Consequently, oil is not a potential threat in the shore zone during the winter. Although oil is only exposed for a relatively short time each summer, the absolute duration of oil persistence in protected Beaufort Sea coastal areas can extend to many years, as evidenced by post-spill monitoring of previous crude oil releases in the arctic (Dickins et al. 1981; Owens et al. 1987).

Table A6

Factors Influencing the Potential Persistence of Oil Stranded in the Shore Zone

A.	Wave Exposure <10 km Fetch 10-100 km Fetch >100 km Fetch	↑	Increasing Residence
B.	Shoreline Morphology Flats/Marshes Beaches Cliffs	↑	Increasing Residence
C.	Shoreline Substrate Organics Gravel Sand Mud	↑	Increasing Residence
D.	Shoreline Stability Accretional Cyclical Beach Cycle Erosional	↑	Increasing Residence
E.	Shore/Ice Interaction Frequent Rare	↑	Increasing Residence

Table A7

Coastal Type Descriptions

Tundra Cliffs

cliffs cut into unconsolidated, but frozen coastal plain sediments; usually rapidly retreating (1 to 2 m/yr); narrow, fringing gravel beaches are frequently associated with the cliffs.

Barrier Islands and Spits

frequently interspersed with tundra cliffs along the coast; the barrier islands and spits are low in elevation, usually less than 2.5 m above mean water level; substrate is most commonly a mixture of sand and gravel; coastal stability is usually controlled by the rate of headland retreat of nearby tundra cliffs although some barrier spits are actually prograding.

Inundated Tundra

very low tundra that has been inundated such that the tundra surface is now below mean water level; in effect a tundra mat extends below the water surface; coastal retreat rates are characteristically high (1 to 2 m/yr), although this coastal type frequently occurs within low wave exposure embayments.

Deltas

included several coastal landforms such as tidal flats, low tundra areas and channel complexes that are found at the seaward terminus of rivers; on the main portion of the Mackenzie River delta, coastal retreat is rapid (>2 m/yr).

Estuaries/Embayments

may include all of the above-mentioned coastal types with the common attribute that they all occur in very low wave energy environments (wave fetch less than 10 km) and are likely to have lengthy potential residence periods.

Table A8
Shore Zone Oil Residence Category

Element	Description	Assigned Value	Weighting Factor	Priority Index
1. Estuaries/ Embayments	Because of extremely low wave exposures, oil persistence is likely to be lengthy for all coastal types that occur within estuaries and embayments.	10	1.5	15.0
2. Deltas	Oil is not expected to readily adhere to tidal flats associated with this coastal type. However, low coastal relief and the presence of numerous channels may allow oil to penetrate into backshore areas where persistence would be lengthy.	7	1.5	10.5
3. Inundated Tundra	Rapid coastal retreat is common to this coastal type, but low coastal relief may result in oil being stranded above the normal wave limit and oil may adhere more tenaciously to the organic substrate.	5	1.5	7.5
4. Barrier Islands and Spits	Relatively high wave exposure of most barrier islands and beaches will result in rapid oil removal. However, the coarse nature of the sediments will allow percolation into the sediments and slightly retard natural cleaning.	4	1.5	6
5. Tundra Cliffs	Rapid coastal retreat is likely to result in a short oil residence period (days to weeks).	2	1.5	3

3.3.2 Application of the Shore Zone Oil Residence

Assessment of shore zone oil residence was complicated by the fact that coastal morphology was mapped in much more detail (see Harper et al. 1985) than the scale of the shoreline sensitivity areas. A wide range of elements were often applicable to one coastal area. For example, when a small coastal lagoon and a tundra cliff occurred within the same area the assigned values ranged from 2 to 10. Therefore, several options were evaluated for applying the oil

residence index values. These included: (1) averaging of the values based on the relative proportion of each coastal type to overall length of coast in the area; (2) assigning the value of the dominant coastal type within the coastal area; and (3) assigning the value of the dominant coastal type and increasing this Assigned Value to reflect more sensitive coastal types within the area. In practice, averaging the values associated with each coastal type proved to be the most straightforward method and provided a realistic picture of the coastal area as a whole. Consequently, this application technique was used for all of

the areas. An example is provided below.

In Area No. 9, 70 percent of the shoreline is tundra cliffs (AV = 2), 20 percent is estuarine-embayment (AV = 10) and 10 percent is beach (AV = 4). The sensitivity was computed as follows:

Type	Assigned Value	Proportion Assigned	Weighted Value	Weighing Factor	Priority Index
Cliff	2	70	1.4	1.50	2.1
Estuary-Embayment	10	20	2.0	1.50	3.0
Beach	4	10	0.4	1.50	<u>0.6</u>
Sensitivity for Area No. 9=					5.7

The sensitivity value is a compromise between the dominant coastal type, which is low in sensitivity, and the higher sensitivity types, which are less common within the area. The presence of estuaries-embayments is clearly indicated on the physical maps, and thereby provides the user with a specific location of estuaries-embayments as well as other coastal types.

3.4 Marine Oil Residence Category

This section outlines the methodology used to develop a marine oil residence category that parallels the shore zone oil residence category described in Section 3.3 of this appendix. The principal objective in this process was to select elements and Assigned Values for the marine category that would approximately correspond to values in the shoreline index, i.e. AV5 (Marine) = AV5 (Shore Zone). The two oil residence indices have been based on vastly different physical, spatial and temporal parameters, and caution must be used in drawing direct comparisons between the actual values. Shore zone oil residence values have been developed for many different areas of the world. However, this project constitutes the first known application of a marine oil residence index, where ice is the dominant physical parameter controlling the residence time for oil.

The concept of oil residence offshore stands in sharp contrast to the concept of oil along the shoreline in terms of not only the duration and period of oil residence, but also the physical factors that affect the fate of oil. Key differences between the concepts of shoreline and marine oil residence are outlined below.

Point of Comparison	Shore Zone Oil Residence	Marine Oil Residence
Period of Maximum Persistence and/or Exposure	Spring/Summer (May-Sept)	Winter/Spring (Oct.-July)
Key Physical Factors	Wave Exposure Coastal Morphology Coastal Stability Substrate	Ice Type Ice Concentration Ice Leads Ice Porosity
Oil Motion	Limited	Extensive

The behaviour of oil offshore is a complex process that depends on a number of competing mechanisms. Oil may be exposed as pools on the ice surface through vertical migration in late May or ice ablation in late June (Norcor 1975; Dickins and Buist 1980), and can be transferred to the marine environment at any time by ice break-up, lead formation or polynya openings (Norcor 1977). Oil spilled in a broken ice environment is prevented from spreading and tends to remain concentrated in local areas within slush and brash ice between the thicker floes (Buist and Bjerkelund 1986). In contrast, oil spilled in a winter landfast ice environment is quickly incorporated within the growing sheet, contained within a local area and isolated from the marine environment until spring (Dickins and Buist 1980). As the ice concentration approaches an open water condition (<3/10 ice), the oil spreads rapidly into thin films. The oil residence period is minimal during the open-water period because of the potential for large daily motions in the order of tens of kilometres and subsequent decrease in oil concentrations. The presence of ice either as evenly

distributed floes or as well defined ice edges (e.g. leads, lagoons, polynya) will act to restrict oil movement and significantly increase the potential oil residence time within a localized area.

3.4.1 Elements in the Marine Oil Residence Category

The singlemost important elements that control the timing, duration and physical location of oil offshore are the ice and/or open water regimes. These are described in Table A9 (following page).

3.4.2 Ranking of Marine Oil Residence Elements

The elements within the Marine Oil Residence Category were assigned values based on the estimated oil residence periods associated with the different ice and open water zones.

Ranges in the estimated oil residence times were used to rank the different elements (i.e., ice and open water zones) in terms of the potential for direct oil exposure (Table A10, page 21). The concept of direct oil exposure was used to differentiate those situations where oil is present as exposed slicks or pools from those cases where oil is present as a distinct lens or layer encapsulated within a growing ice sheet. The latter configuration of oil in ice is considered as a case of indirect exposure. Although oil encapsulated within the ice is still present in the marine environment, it is physically isolated from most biological and human activities.

Assigned values were derived on a relative basis for each element in the marine oil residence category by first defining a value between 1 and 10 for the worst-case element (i.e., the "Polynya Zone"). This was arrived at by considering elements within the shore zone oil residence category which most closely approximated the "Polynya Zone" in terms of the estimated oil residence periods. As a result, the maximum value in the marine oil residence category was set at 7. All subsequent assigned values within the category were then based on the relative range of direct oil exposure times of each element in turn, down to the element with the shortest oil residence time (open water).

Table A10 presents the marine oil residence category that was

developed specifically for this atlas. Each Assigned Value (AV) was multiplied by a weighting factor to arrive at a final Priority Index (PI). Both the marine and shoreline oil residence categories received a Weighting Factor (WF) of 1.5.

The offshore sensitivity areas were deliberately chosen to correspond to average locations of ice zone boundaries (Summary Maps 6 and 8). An exception was made in identifying the "Polynya Zone." In this case a conservative area was chosen based on the maximum historical range of polynya occurrence (see description accompanying Summary Map 7). The marine oil residence index and associated offshore sensitivity rankings were developed separately for the winter/spring and summer/fall periods (see Section 4.0 page 21). The dates used to indicate seasonal transitions were chosen on the basis of median ice conditions offshore. Although freeze-up normally occurs throughout the study region within weeks, break-up can span several months, depending on location. July 16 was used as the transition date between the winter/spring and summer/fall period. By this time, the areal extent of open water offshore approximates that reached during August and September.

Table A9
Description of Ice Regimes Used as Elements in the
Marine Oil Residence Index

Winter/Spring October 2 to July 16

Polynya Zone

- refers specifically to a series of lead systems which expand in open water from east to west to form the Bathurst Polynya as early as March, but more often after mid April. The maximum-observed areal extent of the polynya during the period April to June was used to establish a conservative set of boundaries for this zone on the atlas maps (see Summary Map 7).

Transition Ice Zone

- refers to an area of predominantly first-year pack ice that extends from the northern boundary of the "Polynya" to the southern boundary of the polar pack (predominantly multi-year ice). Ice within the transition zone is mobile all winter, with large spatial variations in thickness and deformation (ridges, rubble, rafting). Note: The term "Transition Zone" is more usually used to denote the entire region between the landfast ice and polar pack. The polynya is highlighted in this atlas as a separate area because of its importance to migrating waterfowl and marine mammals.

Landfast Ice Zone

- consists of a continuous sheet of predominantly first-year ice that is frozen to the shore of the Tuktoyaktuk Peninsula and extends out to approximately 25 m of water by early January. It remains fixed in position until break-up begins in mid June. Between Richards Island and Herschel Island, landfast ice extends across much deeper water beyond 50 m depth, but the ice in this area cannot be considered stable for any extended period. Landfast ice reaches a maximum thickness in May, at which time the ice sheet is frozen to the bottom at water depths out to 2 m. The area of "bottom fast" ice covers a significant offshore area in the shallows of the Mackenzie Delta (see Summary Map 6 and Regional Map 5).

Overflooding Zone

- refers to coastal areas in Mackenzie Bay, Kugmallit Bay and to a lesser extent Wood Bay, which clear of ice up to six weeks prior to break-up of landfast ice offshore. The early clearing of sea ice in these areas is precipitated by river ice break-up in late May. The sudden peak flow of relatively warm fresh water leads to overflooding and rapid deterioration of the "bottom fast" ice in shallow coastal areas (see Regional Map 6 and Figure 11).

Summer/Fall July 17 to October 1

Transition Zone

- refers to an area of predominately first-year ice that is bound by the polar pack to the north and open water to the south. Ice in this zone will tend to change in concentration and appearance on an hourly basis in response to local winds. As the level ice melts, remaining first-year ice will be composed of thicker ice forms such as ridge or rubble field remnants. In favourable summers, the transition zone will melt completely and essentially disappear until freeze-up in October. In extreme summers such as 1974, the transition zone may remain packed into the coast by northerly winds and contain significant concentrations of multi-year ice (see Summary Map 8).

Open Water Zone

- the areal extent of this zone changes rapidly as winds drive pack ice towards and away from shore and is highly variable from year to year. Open water is bound to the north initially by ice remaining from the winter transition zone and in September by the polar pack ice edge. In extremely favourable years open water can extend north of 73° North Latitude, well beyond the area mapped in this atlas (see Summary Map 8).

Table A 10
Marine Oil Residence Category

	Element	Period of Direct Oil Exposure	Assigned Value	Weighting Factor	Priority Index	
Winter/Spring Oct. 2 - July 16	Polynya Zone	Avg. 5 Months	7	1.5	10.5	data available; (2) the relative length of shoreline where countermeasures could be effectively concentrated; and (3) the susceptibility of adjacent areas to oiling from an offshore slick. The boundary between shoreline and offshore areas was approximately one kilometre from the shoreline or from the offshore boundary of areas that are indicated as exposed during low tides. Areas within embayments were included in the shoreline areas. Environmental sensitivity information and boundaries for shoreline areas are shown on Operational Maps 1 to 26, Environmental Sensitivity Series. The backshore limit of the shoreline areas was defined as the log debris line, which is the maximum backshore extent of storm surges in low-lying areas (see Physical Map Series 1 to 26 for this information).
	Transition Zone	weeks - 3.5 months	5	1.5	7.5	
	Landfast Ice Zone	weeks - 2.5 months	4	1.5	6.0	
	Overflooding Zone	days - 1.5 months	3	1.5	4.5	
Summer/Fall July 17 - Oct. 1	Transition Zone	weeks - 2.5 months	4	1.5	6.0	
	Open Water Zone	days - weeks	1	1.5	1.5	

4.0 APPLICATION OF THE ENVIRONMENTAL SENSITIVITY RANKING SYSTEM

The following sections describe the application of the environmental sensitivity ranking system to shoreline and offshore areas and the degree of environmental sensitivity based on the relative sensitivity rankings. Actual ranking values for all areas are tabulated in Section 6.0.

4.1 Definition of Areas for Sensitivity Ranking

Application of the sensitivity ranking system to specific systematically delineated areas of shoreline or offshore water was necessary to eliminate biases that could occur if environmental data were used to define areas and to ensure that all areas were of approximately equivalent size. It was important that the size of areas be similar so that comparisons of sensitivity were congruous. The shoreline between the U.S. border and Cape Bathurst was divided into 69 areas, which were identified by a number and a name of a geographic feature in that area. Some of the considerations in determining the size of the areas were: (1) the level of environmental

Offshore areas extend from the outer boundary of the shoreline areas to the edge of the polar pack ice (Summary Maps 3 and 4). The polar pack was not considered in the development of offshore sensitivity rankings (see discussion accompanying Summary Map 6). The division of offshore waters into areas for application of the sensitivity ranking was based partially on the boundaries of the ice and open water zones described in the marine oil residence category. Arbitrarily dividing the offshore waters by using criteria parallel to those used for the shoreline was rejected because of the difficulty of applying the marine oil residence category to an area that encompassed dynamic, seasonal ice or ice/open water zones. It was considered logical that the offshore areas be larger than the shoreline areas since: (1) the environmental data for offshore areas is less site specific; and (2) oil can spread relatively quickly under certain offshore conditions before any countermeasures are initiated.

The most important elements controlling the timing, duration and physical location of oil offshore are the ice and/or open water regimes. For this reason, five zones were used as elements in the marine oil residence category and formed the longitudinal boundaries of the

offshore areas (see Section 3.4 for further details). Seasonal variations in ice conditions change the boundaries and the existence of certain marine sensitivity areas from winter to summer, and consequently the offshore sensitivity rankings were developed separately for winter/spring and summer/fall. During the summer/fall period (17 July - 1 October), the offshore was divided into two zones (open water and transition) and the open water zone was further divided by approximately the 20 m depth contour. During the winter/spring period (2 October - 16 July), the offshore was divided into four zones (polynya, transition, landfast and over flooding). Delineation of the offshore sensitivity areas was accomplished by using lines of latitude.

A total of 26 areas were defined offshore; 11 during summer/fall and 15 during winter/spring (Summary Maps 3 and 4). Each area was identified by a number.

The sensitivity rankings for the summer/fall offshore and shoreline areas were combined, while the rankings for the winter/spring offshore areas were considered separately in the overall analysis of environmental sensitivity. The reason for this was because oil spilled in offshore areas during winter would, in almost all circumstances, not reach shorelines until the following summer due to the barrier of landfast ice, and the fact that most ice zones tend to contain oil until breakup (Section 3.4). Although the environmental sensitivity of the offshore areas during winter/spring was ranked separately from the offshore areas during summer/fall, it was still based on the same basic categories.

4.2 Definition of Low, Moderate and High Sensitivity

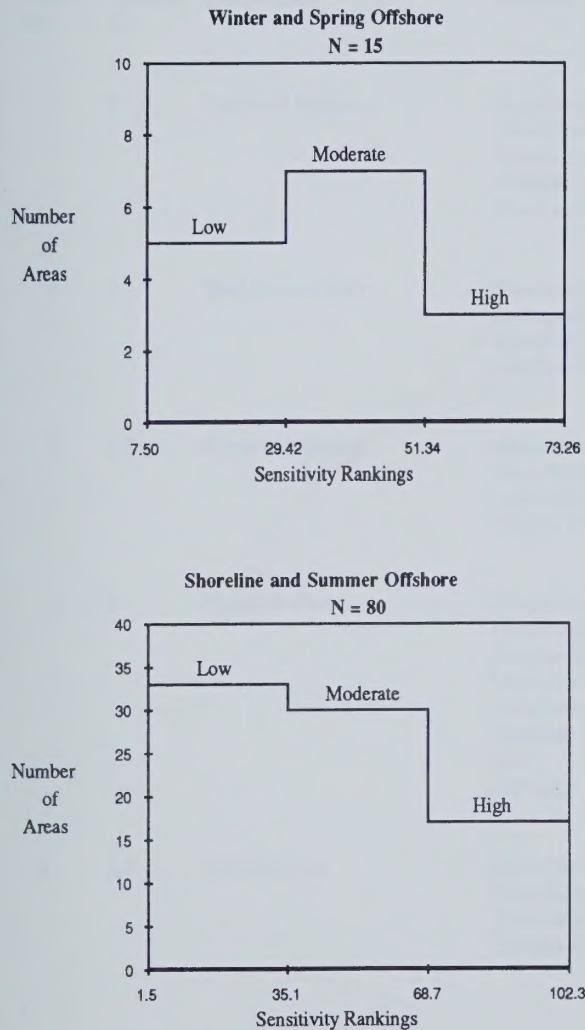
Ranking of the shoreline and offshore areas was simplified to three degrees of sensitivity (LOW, MODERATE AND HIGH) to allow quick determination of their relative sensitivity to an oil spill, and eliminate judgements on the significance of small differences in the rankings.

The divisions between low, moderate and high were based on an even division of the absolute range in the rankings for winter/spring and for summer/fall. Figure A1 shows the actual frequency distributions of the rankings for the three sensitivity categories. The rankings for the shoreline and offshore areas during summer/fall ranged from 1.5

to 102.3, while the rankings for the offshore areas during winter/spring ranged from 7.5 to 73.26. The ranges for low, moderate and high are as follows:

1. Shoreline and offshore areas (summer/fall):
 LOW = 1.5 to 35.10
 MODERATE = 35.10 to 68.70
 HIGH = 68.70 to 102.30
2. Offshore areas (winter/spring):
 LOW = 7.5 to 29.42
 MODERATE = 29.42 to 51.34
 HIGH = 51.34 to 73.26

Figure A1
Frequency Distribution of Environmental Sensitivity Rankings



The environmental sensitivity maps can be used to estimate the relative sensitivity of offshore areas versus threatened shoreline areas during the open-water period, although users should be aware of the limitations of the system (see Section 5.0). The evaluation of the offshore environment was a key objective of this atlas, and the ranking system was modified specifically to allow comparisons between offshore and shoreline areas. Sections 3.3 and 3.4 described the approach used to develop the marine and shore zone oil residence categories. The biological sensitivity category is also intended for application in both marine and shoreline areas, and the human use sensitivity category takes into consideration important offshore areas that are used for resource harvesting.

5.0 LIMITATIONS

The sensitivity ranking system has incorporated those elements that represent key features of the Beaufort Sea environment and has allowed areas within the region to be prioritized according to their sensitivity to an oil spill. However, there are limitations to any ranking system because of the complexity of the natural environment and the uniqueness of each spill event.

Although a numerical ranking system is the most efficient method of comparing the large number of shoreline and offshore areas in the Beaufort Sea region, it can be misleading. It is important to note that the numbers assigned to the elements within each category do not represent their value to residents of the region or their importance in the entire system, but are intended as a measure of their relative sensitivity to the effects of oil or a spill event. The ranking of each element required a thorough knowledge of the effects of oil. However, information on the effects of oil was limited for some of the resources, and consequently there is a degree of uncertainty and subjectivity associated with each rating. The cumulative effect of this on the overall sensitivity rankings can not be determined, and therefore small differences in the ranking of areas are insignificant. The degree of sensitivity (high, moderate or low) has been defined by a purely mathematical division of the total range in sensitivity values. Consequently, the sensitivity rating of each area should be considered in relation to its numerical position within the distribution shown in Figure A1 and in relation to the values of adjacent sensitivity areas.

It is important to recognize that this ranking system has been developed solely to describe environmental sensitivity to oil spill effects in the Beaufort Sea region. A modification of this system may be useful in determining oil spill effects in other areas, but in its present form it is specific to the Beaufort Sea environment. In addition, it should also be recognized that areas designated as highly sensitive to oil spill effects may also be sensitive to the effects of other industry activities. However, such an occurrence is coincidental, and areas designated as highly sensitive on the atlas maps should not be considered "sensitive" to any other disturbances.

The purpose of the ranking system is to provide an On-Scene-Commander and others in charge of responding to an oil spill with a system that prioritizes areas for protection and cleanup when a large area is threatened. It does not imply that a "low-sensitivity" area should not be protected or cleaned in the event of a spill. Section 6.0 lists the elements that form the sensitivity ranking for each sensitivity area. This list should be used to supplement the summary information shown on the maps in order to determine the environmental resources in each area and to select the most appropriate contingency strategies.

In conclusion, the sensitivity ranking system provides a scheme to compare the sensitivity of particular areas of the Beaufort Sea region with respect to oil spill effects, and to determine priorities for protection and cleanup. There will always be a degree of subjectivity and uncertainty associated with sensitivity ranking systems because of the complexity of natural systems and the uniqueness of circumstances surrounding any specific oil spill event. Despite the limitations of the ranking system, the atlas incorporates the best available knowledge of the Beaufort Sea environment and the effects of oil on northern resources.

6.1 Shoreline Environmental Sensitivity Rankings

Area No.	Op.Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
1	1	Clarence Lagoon	Archaeological sites (3)	6.00	2.00	12.00	43.50 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			National Park	4.00	2.00	8.00	
			Caribou	4.00	1.75	7.00	
			Tundra cliff (Estuaries 20%)	4.00	1.50	6.00	
2	1	Backhouse River	Nearshore fish habitat	6.00	1.75	10.50	31.50 Low
			Archaeological site (1)	5.00	2.00	10.00	
			National Park	4.00	2.00	8.00	
			Tundra cliff	2.00	1.50	3.00	
3	1,2	Komakuk Beach	Important to residents	6.00	2.00	12.00	33.95 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			National Park	4.00	2.00	8.00	
			Tundra cliff	2.30	1.50	3.45	
4	2	Nunaluk Spit	Diving ducks	9.00	1.75	15.75	82.25 High
			Important to residents	6.00	2.00	12.00	
			Estuary/Embayment	8.00	1.50	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			National park	4.00	2.00	8.00	
			Fox	4.00	1.75	7.00	
			Caribou	4.00	1.75	7.00	
5	2,3	Avadlek Spit	Important to residents	6.00	2.00	12.00	34.70 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			Territorial Park	4.00	2.00	8.00	
			Tundra cliff	2.80	1.50	4.20	

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Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
6	2,3	Workboat Passage	Highly important to residents	8.00	2.00	16.00	89.45 High
			Diving ducks and shorebirds	9.00	1.75	15.75	
			Estuary/Embayment	8.80	1.50	13.20	
			Archaeological sites (6)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			National and territorial park	4.00	2.00	8.00	
			Caribou	4.00	1.75	7.00	
			Fox	4.00	1.75	7.00	
7	3	North Herschel Island	Black guillemots	10.00	1.75	17.50	49.00 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological site (1)	5.00	2.00	10.00	
			Territorial park	4.00	2.00	8.00	
			Tundra cliff	2.00	1.50	3.00	
8	3	Thetis Bay	Greatest importance to residents	10.00	2.00	20.00	71.30 High
			Black guillemots	10.00	1.75	17.50	
			Archaeological sites (3)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Territorial park	4.00	2.00	8.00	
			Tundra cliff	2.20	1.50	3.30	
9	3,4	Whale Bay	Diving ducks	9.00	1.75	15.75	68.95 High
			Important to residents	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			National park	4.00	2.00	8.00	
			Fox	4.00	1.75	7.00	
			Tundra cliff (Estuaries 20%)	3.80	1.50	5.70	
10	4	Stokes Point	Highly important to residents	8.00	2.00	16.00	83.45 High
			Diving ducks	9.00	1.75	15.75	
			Archaeological sites (6)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			National park	4.00	2.00	8.00	
			Tundra cliff (Estuaries 20%)	4.80	1.50	7.20	
			Fox	4.00	1.75	7.00	
			Caribou	4.00	1.75	7.00	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
11	4	Phillips Bay	Highly important to residents	8.00	2.00	16.00	89.15 High
			Diving ducks and brant	9.00	1.75	15.75	
			Estuary/Embayment	8.60	1.50	12.90	
			Archaeological sites (5)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			National park	4.00	2.00	8.00	
			Fox	4.00	1.75	7.00	
			Caribou	4.00	1.75	7.00	
12	4	Babbage Bight	Important to residents	6.00	2.00	12.00	32.50 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	
			Tundra cliff	2.00	1.50	3.00	
13	5	King Point	Highly important to residents	8.00	2.00	16.00	62.20 Moderate
			Bowhead whales	7.00	1.75	12.25	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			Caribou	4.00	1.75	7.00	
			Tundra cliff (Estuaries 5%)	4.30	1.50	6.45	
14	5	Sabine Point	Bowhead whales	7.00	1.75	12.25	50.95 Moderate
			Archaeological sites (4)	6.00	2.00	12.00	
			Important to residents	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Tundra cliffs (Estuaries 10%)	2.80	1.50	4.20	
15	5	Shingle Point	Greatest importance to residents	10.00	2.00	20.00	48.15 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological site (1)	5.00	2.00	10.00	
			Tundra cliff (Estuaries 35%)	5.10	1.50	7.65	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
16	5,6	Trent Bay	Greatest importance to residents	10.00	2.00	20.00	
			Seabirds (glaucous gulls)	9.00	1.75	15.75	
			Swans and geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological site (1)	5.00	2.00	10.00	
			Caribou	4.00	1.75	7.00	
			Delta	5.10	1.50	7.65	
							84.90 High
17	6	Shoalwater Bay	Greatest importance to residents	10.00	2.00	20.00	
			Swans and geese	8.00	1.75	14.00	
			White whales	6.00	1.75	10.50	
			Nearshore fish habitat	6.00	1.75	10.50	
			Delta	7.00	1.50	10.50	
			Caribou	4.00	1.75	7.00	
							72.50 High
18	6,7,8	West Channel	Highly important to residents	8.00	2.00	16.00	
			Swans and geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Delta	7.00	1.50	10.50	
							51.00 Moderate
19	7,8	Outer Shallow Bay	Highly important to residents	8.00	2.00	16.00	
			Brant	9.00	1.75	15.75	
			Estuary/embayment	10.00	1.50	15.00	
			Swans and geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
							71.25 High
20	8	Inner Shallow Bay	Highly important to residents	8.00	2.00	16.00	
			Brant	9.00	1.75	15.75	
			Estuary/embayment	10.00	1.50	15.00	
			Swans and geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
							71.25 High

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
21	7,9	Olivier Islands	Highly important to residents	8.00	2.00	16.00	52.75 Moderate
			Brant	9.00	1.75	15.75	
			Nearshore fish habitat	6.00	1.75	10.50	
			Delta	7.00	1.50	10.50	
22	9,10	Ellice Island	Highly important to residents	8.00	2.00	16.00	52.75 Moderate
			Brant	9.00	1.75	15.75	
			Nearshore fish habitat	6.00	1.75	10.50	
			Delta	7.00	1.50	10.50	
23	10	Garry Island	Highly important to residents	8.00	2.00	16.00	44.40 Moderate
			Geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Tundra cliff	2.60	1.50	3.90	
24	10	Kendall Island	Greatest importance to residents	10.00	2.00	20.00	63.50 Moderate
			Geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			Delta	6.00	1.50	9.00	
25	10,11	Taglu Island	Geese	8.00	1.75	14.00	35.00 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			Delta	7.00	1.50	10.50	
26	11	West Point	Brant	9.00	1.75	15.75	53.00 Moderate
			Dabbling ducks, swans and geese	8.00	1.75	14.00	
			Estuary/Embayment	8.50	1.50	12.75	
			Nearshore fish habitat	6.00	1.75	10.50	
27	12	Pelly Island	Nearshore fish habitat	6.00	1.75	10.50	15.00 Low
			Tundra cliff (Beach 50%)	3.00	1.50	4.50	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
28	12	Hooper Island	Nearshore fish habitat	6.00	1.75	10.50	15.30 Low
			Beach (Tundra cliff 50%)	3.20	1.50	4.80	
29	13	North Point	Nearshore fish habitat	6.00	1.75	10.50	13.65 Low
			Tundra cliff	2.10	1.50	3.15	
30	13	North Head	Diving ducks	9.00	1.75	15.75	36.00 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			Estuary/Embayment	6.50	1.50	9.75	
31	13	Pullen Island	Nearshore fish habitat	6.00	1.75	10.50	15.90 Low
			Beach	3.60	1.50	5.40	
32	11,13,14	Mason Bay	Diving ducks	9.00	1.75	15.75	59.20 Moderate
			Important to residents	6.00	2.00	12.00	
			Estuary/Embayment	7.30	1.50	10.95	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
33	14	Kidluit Bay	Highly important to residents	8.00	2.00	16.00	51.35 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			White whales	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			Tundra cliff (Estuaries 5%)	2.90	1.50	4.35	
34	14	Kittigazuit Bay	Greatest importance to residents	10.00	2.00	20.00	66.10 Moderate
			Geese	8.00	1.75	14.00	
			Archaeological sites (4)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Delta (Estuaries 5%)	6.40	1.50	9.60	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
35	14	Hendrickson Island	Greatest importance to residents	10.00	2.00	20.00	35.30 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			Tundra cliff (Estuaries 10%)	3.20	1.50	4.80	
36	14	Canyanek Inlet	Greatest importance to residents	10.00	2.00	20.00	58.20 Moderate
			Geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Pingo Landmark site	4.00	2.00	8.00	
			Tundra cliff (Estuaries 20%)	3.80	1.50	5.70	
37	14,15	Tuktoyaktuk	Greatest importance to residents	10.00	2.00	20.00	81.63 High
			Community of Tuktoyaktuk	10.00	2.00	20.00	
			Estuary/Embayment	8.75	1.50	13.13	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			Pingo Landmark site	4.00	2.00	8.00	
38	15	Tibjak Point	Greatest importance to residents	10.00	2.00	20.00	60.50 Moderate
			Geese	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological site (1)	5.00	2.00	10.00	
			Beach (Estuaries 10%)	4.00	1.50	6.00	
39	15,16	Kukjuktuk Bay	Greatest importance to residents	10.00	2.00	20.00	59.15 Moderate
			Diving ducks	9.00	1.75	15.75	
			Nearshore fish habitat	6.00	1.75	10.50	
			Estuary/Embayment	8.60	1.50	12.90	
40	16	Tuft Point	Highly important to residents	8.00	2.00	16.00	32.50 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			Beach (Estuaries 10%)	4.00	1.50	6.00	

Area No.	Op.Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
41	16	Hutchison Bay	Highly important to residents	8.00	2.00	16.00	65.90 Moderate
			Diving ducks	9.00	1.75	15.75	
			Estuary/Embayment	9.10	1.50	13.65	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
42	16,17	Drift Point	Diving ducks	9.00	1.75	15.75	38.63 Moderate
			Estuary/Embayment	8.25	1.50	12.38	
			Nearshore fish habitat	6.00	1.75	10.50	
43	17,18	Atkinson Point	Greatest importance to residents	10.00	2.00	20.00	75.65 High
			Diving ducks and brant	9.00	1.75	15.75	
			Estuary/Embayment	8.10	1.50	12.15	
			Archaeological sites (7)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Reindeer	3.00	1.75	5.25	
44	17,18	Crescent Bank	Estuary/Embayment	8.70	1.50	13.05	28.80 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			Reindeer	3.00	1.75	5.25	
45	18,19	Nuvorak Point	Estuary/Embayment	9.20	1.50	13.80	29.55 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			Reindeer	3.00	1.75	5.25	
46	19	Russell Inlet	Estuary/Embayment	8.40	1.50	12.60	28.35 Low
			Nearshore fish habitat	6.00	1.75	10.50	
			Reindeer	3.00	1.75	5.25	
47	19	Cape Dalhousie	Estuary/Embayment	7.90	1.50	11.85	37.60 Moderate
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological site (1)	5.00	2.00	10.00	
			Reindeer	3.00	1.75	5.25	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
48	19	Char Point	Nearshore fish habitat	6.00	1.75	10.50	24.75 Low
			Estuary/Embayment (Tundra cliff 50%)	6.00	1.50	9.00	
			Reindeer	3.00	1.75	5.25	
49	20	Johnson Bay	Nearshore fish habitat	6.00	1.75	10.50	21.15 Low
			Tundra cliff (Estuaries 20%)	3.60	1.50	5.40	
			Reindeer	3.00	1.75	5.25	
50	20,23	Nicholson Island	Nearshore fish habitat	6.00	1.75	10.50	21.25 Low
			Caribou	4.00	1.75	7.00	
			Tundra cliff	2.50	1.50	3.75	
51	20,23	Cliff Point	Nearshore fish habitat	6.00	1.75	10.50	20.50 Low
			Caribou	4.00	1.75	7.00	
			Tundra cliff	2.00	1.50	3.00	
52	20,23	Anderson River	Greatest importance to residents	10.00	2.00	20.00	102.30 High
			Eskimo curlew	10.00	1.75	17.50	
			Brant and diving ducks	9.00	1.75	15.75	
			Dabbling ducks, swans and geese	8.00	1.75	14.00	
			Archaeological sites (9)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	
			Tundra cliff	3.70	1.50	5.55	
53	21	North Liverpool Bay	Nearshore fish habitat	6.00	1.75	10.50	13.50 Low
			Tundra cliff	2.00	1.50	3.00	
54	21	Northwest Liverpool Bay	Nearshore fish habitat	6.00	1.75	10.50	26.20 Low
			Archaeological sites (2)	5.00	2.00	10.00	
			Tundra cliff (Estuaries 20%)	3.80	1.50	5.70	

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Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
55	21	South Liverpool Bay	Nearshore fish habitat	6.00	1.75	10.50	23.50 Low
			Archaeological site (1)	5.00	2.00	10.00	
			Tundra cliff	2.00	1.50	3.00	
56	22	Turnabout Point	Nearshore fish habitat	6.00	1.75	10.50	13.50 Low
			Tundra cliff	2.00	1.50	3.00	
57	22	Smoke River	Highly important to residents	8.00	2.00	16.00	69.25 High
			Brant	9.00	1.75	15.75	
			Geese and swans	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	
			Tundra cliff	4.00	1.50	6.00	
58	22	Thumb Island	Highly important to residents	8.00	2.00	16.00	78.65 High
			Brant and diving ducks	9.00	1.75	15.75	
			Geese and swans	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological site (1)	5.00	2.00	10.00	
			Caribou	4.00	1.75	7.00	
			Tundra cliff (Estuaries 20%)	3.60	1.50	5.40	
59	22A	Kugaluk River	Greatest importance to residents	10.00	2.00	20.00	87.25 High
			Brant and diving ducks	9.00	1.75	15.75	
			Estuary/Embayment	10.00	1.50	15.00	
			Geese and swans	8.00	1.75	14.00	
			Archaeological sites (4)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
60	22	Campbell Island	Nearshore fish habitat	6.00	1.75	10.50	18.00 Low
			Inundated tundra (Estuaries 15%)	5.00	1.50	7.50	
61	22	West Liverpool Bay	Nearshore fish habitat	6.00	1.75	10.50	24.70 Low
			Archaeological site (1)	5.00	2.00	10.00	
			Tundra cliff (Estuaries 10%)	2.80	1.50	4.20	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
62	23,24	Mason River	Brant and diving ducks	9.00	1.75	15.75	64.45 Moderate
			Swans	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Archaeological sites (2)	5.00	2.00	10.00	
			Caribou	4.00	1.75	7.00	
			Tundra cliff (Estuaries 30%)	4.80	1.50	7.20	
63	24	Cape Wolki	Brant and diving ducks	9.00	1.75	15.75	50.85 Moderate
			Swans	8.00	1.75	14.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	
			Tundra cliff	2.40	1.50	3.60	
64	24,25	Maitland Point	Highly important to residents	8.00	2.00	16.00	62.30 Moderate
			Diving ducks	9.00	1.75	15.75	
			Estuary/Embayment	8.70	1.50	13.05	
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	
65	25	Harrowby Bay	Greatest importance to residents	10.00	2.00	20.00	92.30 High
			Diving ducks	9.00	1.75	15.75	
			Geese	8.00	1.75	14.00	
			Estuary/Embayment	8.70	1.50	13.05	
			Archaeological sites (4)	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	
66	25,26	Cy Peck Inlet	Nearshore fish habitat	6.00	1.75	10.50	27.40 Low
			Estuary/Embayment	6.60	1.50	9.90	
			Caribou	4.00	1.75	7.00	
67	26	Snowgoose Passage	Diving ducks	9.00	1.75	15.75	59.35 Moderate
			Estuary/Embayment	9.40	1.50	14.10	
			Important to residents	6.00	2.00	12.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			Caribou	4.00	1.75	7.00	

Area No.	Op. Map No.	Area Name	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
68	26	Baillie Islands	Nearshore fish habitat	6.00	1.75	10.50	23.50 Low
			Archaeological site (1)	5.00	2.00	10.00	
			Tundra cliff	2.00	1.50	3.00	
69	26	Cape Bathurst	Nearshore fish habitat	6.00	1.75	10.50	20.80 Low
			Caribou	4.00	1.75	7.00	
			Tundra cliff	2.20	1.50	3.30	

6.2 Offshore Environmental Sensitivity Rankings

Area No.	Map No.*	Time Period	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
101	S5	Summer/Fall	Polar bears	7.00	1.75	12.25	18.25 Low
			Transition zone	4.00	1.50	6.00	
102	S5	Summer/Fall	Polar bears	7.00	1.75	12.25	18.25 Low
			Transition zone	4.00	1.50	6.00	
103	S5	Summer/Fall	Polar bears	7.00	1.75	12.25	18.25 Low
			Transition zone	4.00	1.50	6.00	
104	S5 & R2W	Summer/Fall	Black guillemots	10.00	1.75	17.50	31.25 Low
			Bowhead whales	7.00	1.75	12.25	
			Open water zone	1.00	1.50	1.50	
105	S5 & R2W&E	Summer/Fall	Open water zone	1.00	1.50	1.50	1.50 Low
106	S5 & R2E	Summer/Fall	Ringed seals	7.00	1.75	12.25	38.25 Moderate
			Bowhead whales	7.00	1.75	12.25	
			Bearded seals	7.00	1.75	12.25	
			Open water zone	1.00	1.50	1.50	
107	S5 & R2E	Summer/Fall	Polar bears	7.00	1.75	12.25	13.75 Low
			Open water zone	1.00	1.50	1.50	
108	S5 & R2W	Summer/Fall	Greatest importance to residents	10.00	2.00	20.00	60.00 Moderate
			Black guillemots	10.00	1.75	17.50	
			Bowhead whales	7.00	1.75	12.25	
			Offshore fish habitat	5.00	1.75	8.75	
			Open water zone	1.00	1.50	1.50	

Area No.	Map No.*	Time Period	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
207	S4 & R1E	Winter/Spring	Diving ducks	9.00	1.75	15.75	73.25 High
			Bearded seals	7.00	1.75	12.25	
			Polar bears	7.00	1.75	12.25	
			Important to residents	6.00	2.00	12.00	
			White whales	6.00	1.75	10.50	
			Polynya zone	7.00	1.50	10.50	
208	S4 & R1E	Winter/Spring	Diving ducks	9.00	1.75	15.75	61.00 High
			Bearded seals	7.00	1.75	12.25	
			Important to residents	6.00	2.00	12.00	
			White whales	6.00	1.75	10.50	
			Polynya zone	7.00	1.50	10.50	
209	S4 & R1W	Winter/Spring	Black guillemots	10.00	1.75	17.50	54.75 High
			Important to residents	6.00	2.00	12.00	
			White whales	6.00	1.75	10.50	
			Offshore fish habitat	5.00	1.75	8.75	
			Landfast ice zone	4.00	1.50	6.00	
210	S4 & R1W&E	Winter/Spring	Highly important to residents	8.00	2.00	16.00	41.25 Moderate
			White whales	6.00	1.75	10.50	
			Offshore fish habitat	5.00	1.75	8.75	
			Landfast ice zone	4.00	1.50	6.00	
211	S4 & R1E	Winter/Spring	Highly important to residents	8.00	2.00	16.00	46.50 Moderate
			Diving ducks	9.00	1.75	15.75	
			Offshore fish habitat	5.00	1.75	8.75	
			Landfast ice zone	4.00	1.50	6.00	
212	S4 & R1E	Winter/Spring	Highly important to residents	8.00	2.00	16.00	46.50 Moderate
			Diving ducks	9.00	1.75	15.75	
			Offshore fish habitat	5.00	1.75	8.75	
			Landfast ice zone	4.00	1.50	6.00	

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Area No.	Map No.*	Time Period	Element	Assigned Value	Weighting Factor	Priority Index	Sensitivity Ranking
213	S4 & R1W	Winter/Spring	Greatest importance to residents	10.00	2.00	20.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			White whales	6.00	1.75	10.50	
			Overflooding zone	3.00	1.50	4.50	
							45.50 Moderate
214	S4 & R1W&E	Winter/Spring	Greatest importance to residents	10.00	2.00	20.00	
			Nearshore fish habitat	6.00	1.75	10.50	
			White whales	6.00	1.75	10.50	
			Overflooding zone	3.00	1.50	4.50	
							45.50 Moderate
215	S4 & R1E	Winter/Spring	Nearshore fish habitat	6.00	1.75	10.50	
			Overflooding zone	3.00	1.50	4.50	
							15.00 Low

* S = Summary Map
R = Regional Map
W = West
E = East

6.3 LITERATURE CITED

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APPENDIX B. CLIMATIC DATA FOR LOGISTICS

1.0 INTRODUCTION

Climate along the Beaufort Sea coast is generally not representative of that of only a few miles inland due to the modifying effects of the ocean and to the terrain. Two shore stations were chosen to be representative of the climate along the Beaufort Sea coast: Shingle Point DEW Line site, Yukon (Regional Maps for Mackenzie Bay) and Tuktoyaktuk DEW Line site, N.W.T. (Regional Maps for Tuktoyaktuk Peninsula). Climatic records for Shingle Point and Tuktoyaktuk cover the period from 1973 to 1984 and from 1958 to 1984, respectively. Offshore climatic data from drillships, mainly Dome Petroleum drill ships, and drill rigs are for the period 1976 to 1985. All data were obtained from Atmospheric Environment Service's computer archives (25). This section is not intended as a comprehensive presentation of Beaufort Sea climate. For more detailed descriptions of historical coastal climate and recent offshore observations refer to (4) and (26, 27).

Climatic data presented for the three stations were selected on the basis of their relevance to oil spill countermeasures response. For example:

- Air temperature (Figures 1, 9, and 17) and wind chill (Figures 2, 10, and 18) affect the performance of people and equipment during clean-up operations.
- Wind speeds >15 knots (Figures 5, 13, and 25) will begin to limit the use of containment booming, aerial igniters, aerial dispersant application, and in-situ burning of oil in melt pools on ice in June and July.
- Wind speed and wind direction (Figures 5-8, 13-16, and 25-28) affect surface water and ice movements and hence oil slick movement.
- Visibility (as Fair Weather in Figures 3, 11, and 19 and as Flying Weather in Figures 4, 12, and 20) and Daylight Hours (Figure 24) affect surface travel and vessel and aircraft operations for surveillance, aerial photography, and clean-up activities.
- Wave heights from 0.5 m up to 1.5 m (Figure

23) increasingly limit the effectiveness of containment booming.

2.0 USERS' NOTES

References

References are indicated by numbers in brackets (see Section 5.2 for Physical Environment references).

Wind Speed and Direction

Terrain plays a dominant role in determining local wind patterns along the Yukon coast. At Shingle Point the strongest winds are from the SW direction during the winter months, while the most frequent winds are from the WNW (Figures 6-8). It is suspected that strong SW winds occur when very cold air occurs in the northern Yukon, south of the Brooks Mountain range, or when a trough of low pressure occurs off the coast. These conditions cause an outflow of cold, dense air through the Blow River valley and the Shingle Point area (28). It is likely that these strong SW winds also occur at King Point and the Babbage River valley (29).

At Tuktoyaktuk the frequency of winds from other directions is greater than at Shingle Point as it is located away from the influence of the mountains (Figures 14-16). The strongest winds at Tuktoyaktuk tend to be from the NW. This is expected as NW winds occur behind lows or cold fronts over the Beaufort Sea when the airmass is more likely to be unstable. Strong NW winds are most frequent in the fall before freeze-up (29).

The strongest and most frequent winds in the offshore region are those from the ENE and the NW (Figures 26-28). Offshore wind measurements often depart from AES standards; the sensors on the rig are not usually at the specified 10 m height.

Wind Speed Duration

Table B1
Wind Duration Statistics for the
Southern Beaufort Sea* (30)

Duration (hrs)	Wind Speed(knots)				
	>25	>30	>35	>40	>45
1-5.9	31(14)	12(5)	4(0)	0(0)	0(0)
6-11.9	7(5)	5(3)	0(1)	1(0)	0(1)
12-17.9	5(7)	0(2)	0(0)	0(0)	0(0)
18-23.9	5(9)	0(0)	1(0)	0(0)	0(0)
24-29.9	1(2)	0(0)	0(0)	0(1)	0(0)
>30	4(2)	1(1)	0(1)	0(0)	0(0)
Maximum Duration (hrs)	52(77)	41(57)	(32)		

*Unbracketed data are number of events occurring at a grid point located just east of McKinley Bay, 1946-1978. Bracketed data are from the Dome data set, 1976-1982.

It is important to note that the September 16-18, 1985 storm that caused the Minuk spill was not a unique event. Maximum wind speeds and durations (westerly winds of ≥ 30 knots for 35 hours) were high but both have been exceeded in a 1982 storm. Wave heights were in the 4 to 5 metre range, which are not unusual for the Beaufort Sea. However, an ocean fetch of about 200 n.mi., combined with the extreme duration of high wind speeds, resulted in persistent heavy seas that toppled a derrick on the artificial island (30).

Wave Height

Wave height measurements are from Dome Petroleum's Explorer ships in deep water and are not representative of wave heights in the shallower, nearshore waters. For an analytical description of wave heights refer to (31).

Wind Chill

Table B2
Examples of Wind Chill (32)

Wind Chill	Physical Effect
1000	No real discomfort.
1400	Shivering, body begins to have difficulty staying warm.
1600	Exposed skin starts to freeze.
2000	Exposed skin freezes within minutes, heat drains rapidly from fingers and toes. Use caution when outdoors for long periods.
>2000	Skin freezes in 1 minute or less. Body has difficulty keeping its core warm. Conditions for outdoor travel becomes dangerous.

Visibility

Visibility is presented in conjunction with wind speed as Frequency of Fair Weather (Figures 3, 11, and 19) and in conjunction with ceiling as Frequency of Flying Weather (Figures 4, 12, and 20). These graphs indicate that the percentage of time that climatic conditions are severe enough to cancel surface, marine, and air operations is very low, usually less than 20%.

Near Shore Currents

Text prepared by B. de Lange Boom (Seakem Oceanography Ltd.).
References (33 - 46).

In general, little or no data on currents exist for the study area. Only the open water season is considered.

Surface currents respond quickly to local winds (typically within one day) both nearshore and on the shelf and currents generally follow the the wind direction. There is no drogue data covering currents in the shallow waters along the coast of the Tuktoyaktuk Peninsula and in

Mackenzie Bay. Also lacking are data taken under changing and light wind conditions.

Within 10 km of shore, currents move parallel to the coast with speeds ranging from 25 cm/s north of Pelly Island to 50 cm/s north of Atkinson Point. Typical surface water movements driven by strong NW winds are shown in the buoy trajectories on Summary Map 11. While there is a lack of data within Mackenzie Bay, a persistent northwesterly current was observed in west Mackenzie Bay with a speed of 10 cm/s off Stokes Point increasing to 25 to 30 cm/s off Herschel Island. During strong persistent east to northeast winds in 1974, the longshore current moved westerly with speeds up to 35 cm/s. East of Herschel Island, in west Mackenzie Bay, northwesterly currents were observed with speeds ranging from 40 to 80 cm/s out of Mackenzie Bay. However, it is not known how close inshore these speeds extend. The currents relax within a 24 hour period after letup of easterly winds.

Subsurface currents in the area are predominantly wind-driven, the response varying markedly with location and depth and being strongest near shore and near the surface. The maximum observed response of near-bottom currents was 1.4% of the surface wind speed. Sub-surface current metre data show three major components: wind forcing (2 to 20 day periods), tides (mainly 0.5 to 1 day periods), and inertial motion (0.5 day period).

Almost no direct observations of currents in the near shore exist. Current speeds during the open water season in Mackenzie Bay were observed in the range of 5 to 90 cm/s. Measurements off the Tuktoyaktuk Peninsula indicate mean speeds of 15 to 20 cm/s with maxima of about 55 cm/s. Directions are along shore and the strongest currents are associated with wind events.

The currents due to river discharge are generally weak except in or near river mouths or in the main part of the Mackenzie River plume. Tidal currents are very weak with the possible exception of constricted channels, as at the entrance to Kukjuktuk Bay. Breaking waves can generate significant currents, particularly along shorelines. These are again associated with wind events. However, no direct measurements of these wave induced currents have been reported.

CLIMATIC DATA FOR LOGISTICS

Figure 1. Air Temperature

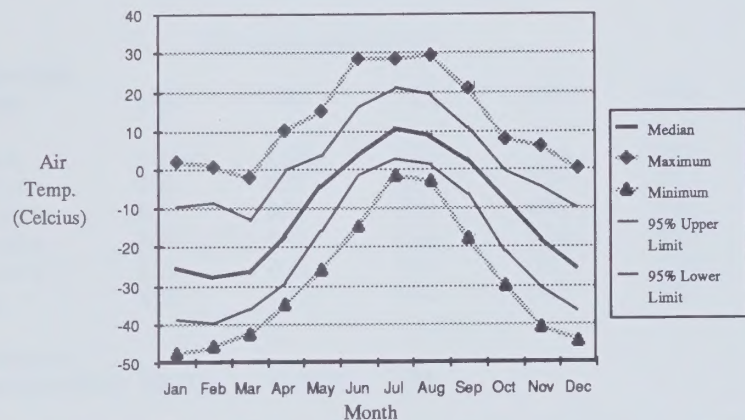
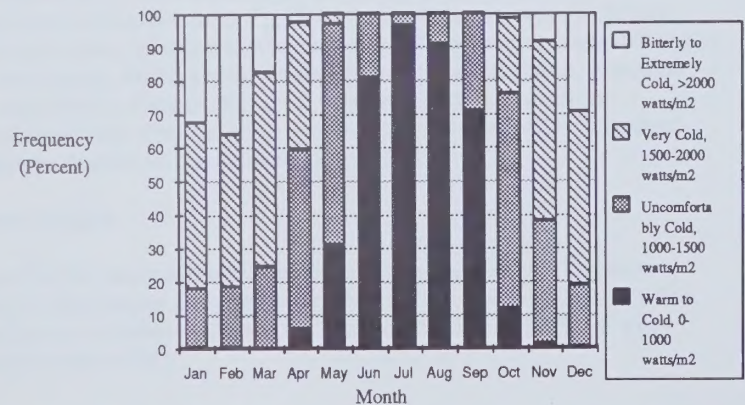


Figure 2. Frequency of Wind Chill Classes



SHINGLE POINT

Figure 3. Frequency of Fair Weather

Visibility Greater Than 2 miles and Winds Less Than 25 knots

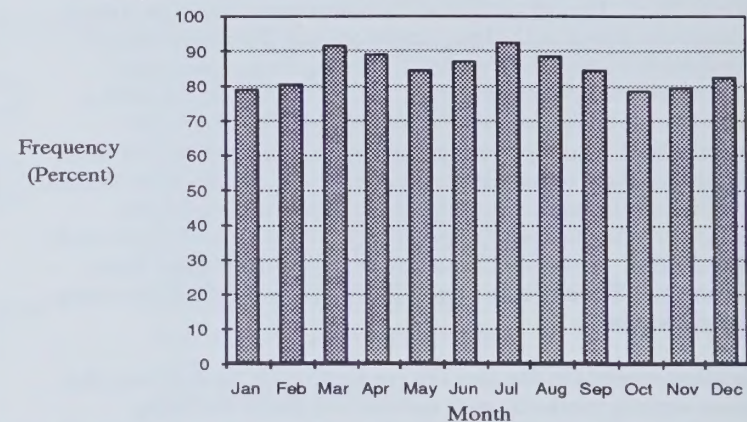
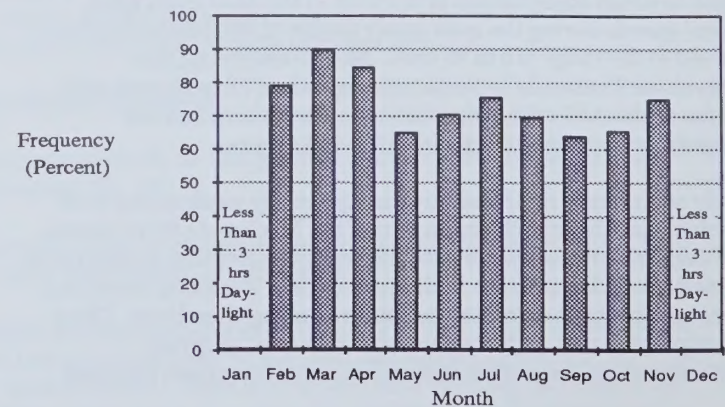


Figure 4. Frequency of Flying Weather

Visual Flight Rules, Ceiling > 1000 ft and Visibility > 2.5 miles



CLIMATIC DATA FOR LOGISTICS

Figure 5. Wind Speed Frequencies

All Directions

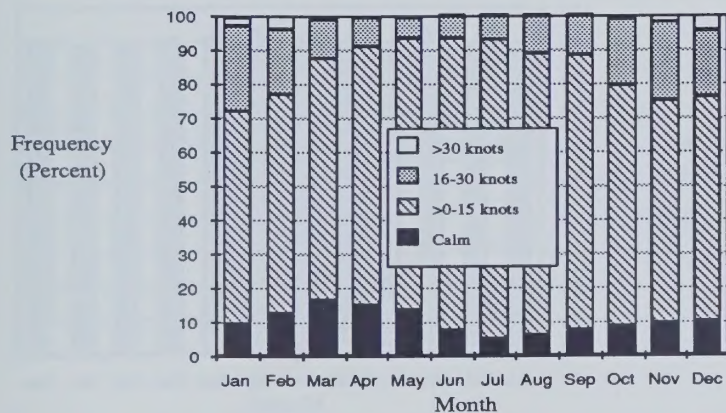


Figure 7. Wind Direction Frequencies

May and June

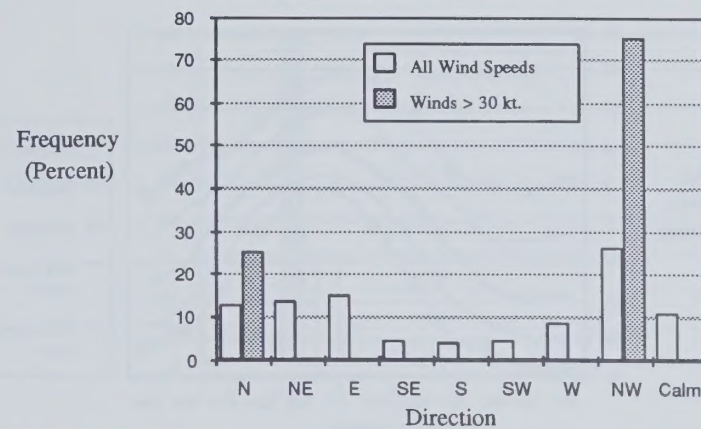


Figure 6. Wind Direction Frequencies

October to April

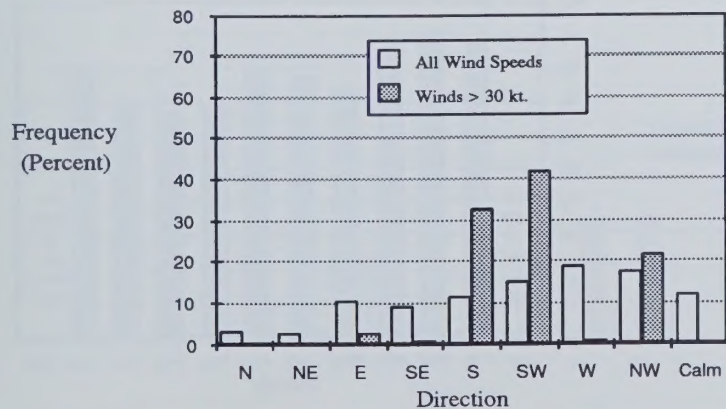
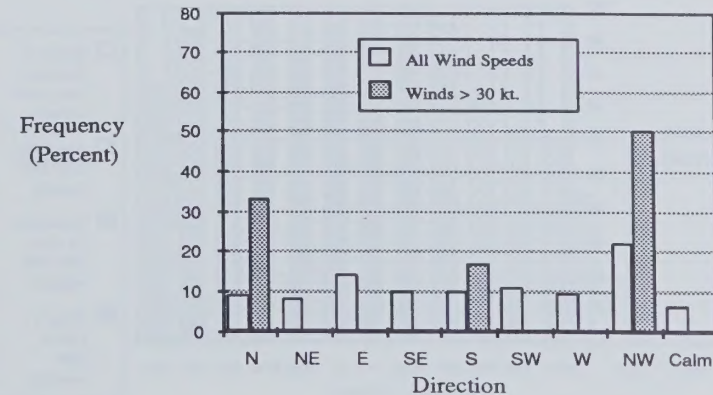


Figure 8. Wind Direction Frequencies

July to September



CLIMATIC DATA FOR LOGISTICS

Figure 9. Air Temperature

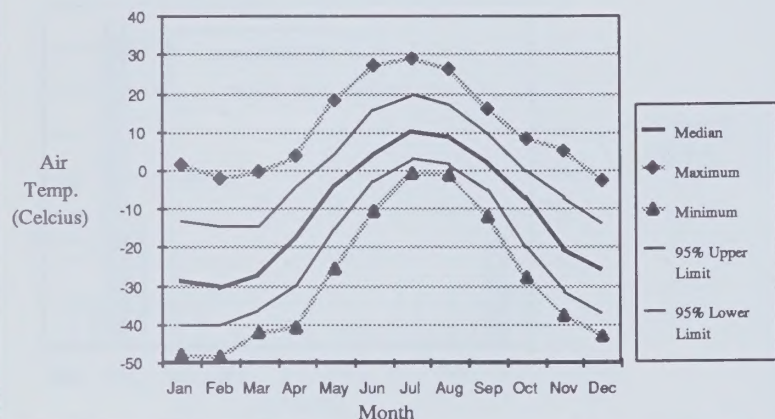
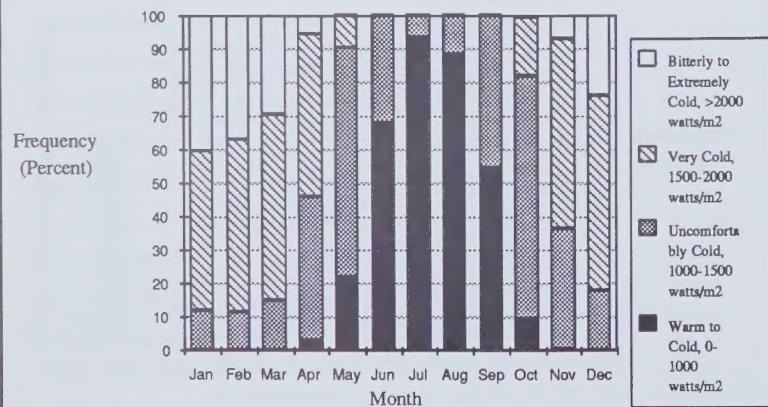


Figure 10. Frequency of Wind Chill Classes



TUKTOYAKTUK

Figure 11. Frequency of Fair Weather

Visibility Greater Than 2 miles and Winds Less Than 25 knots

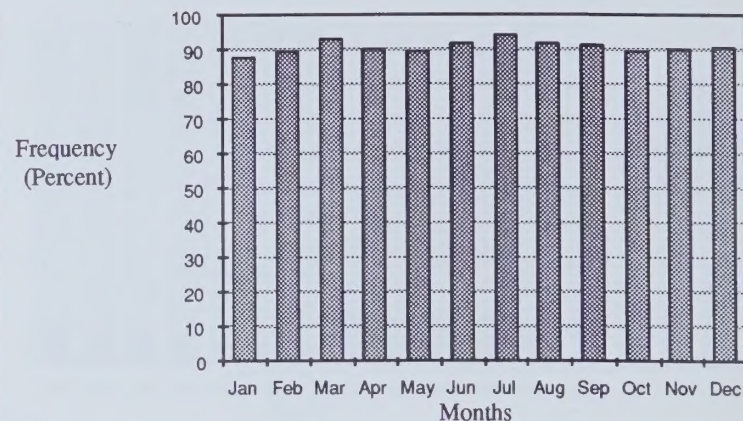
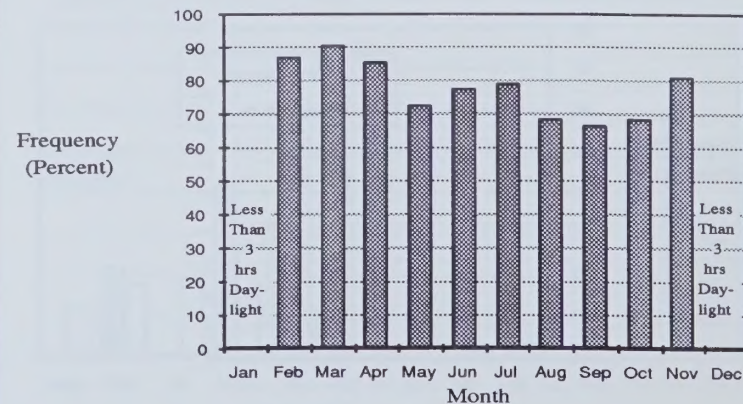


Figure 12. Frequency of Flying Weather

Visual Flight Rules, Ceiling > 1000 ft and Visibility > 2.5 miles



CLIMATIC DATA FOR LOGISTICS

TUKTOYAKTUK

Figure 13. Wind Speed Frequencies

All Directions

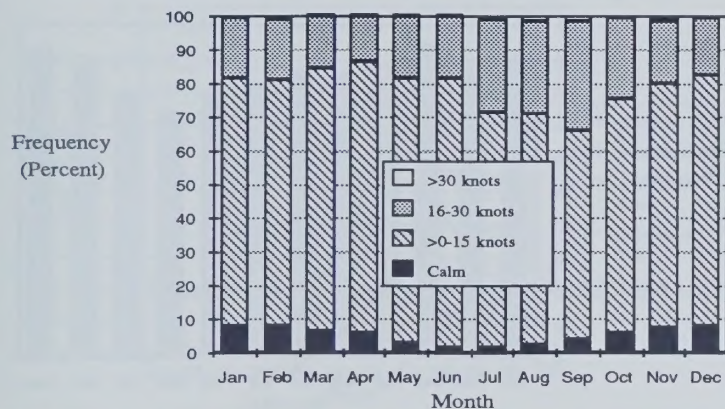


Figure 15. Wind Direction Frequencies

May and June

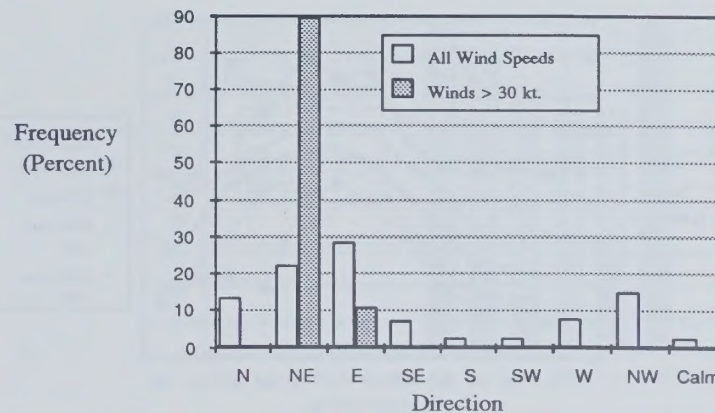


Figure 14. Wind Direction Frequencies

October to April

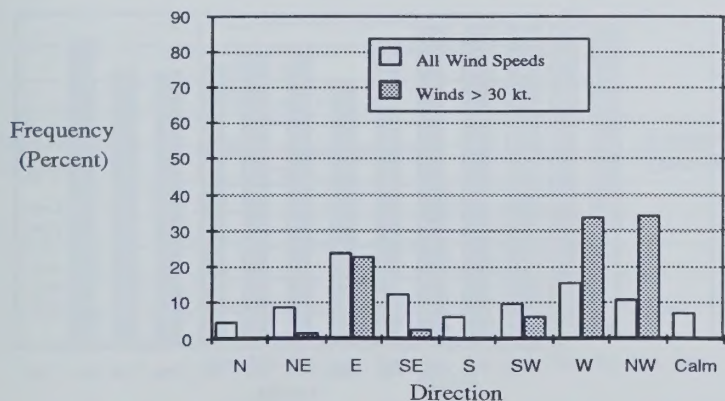
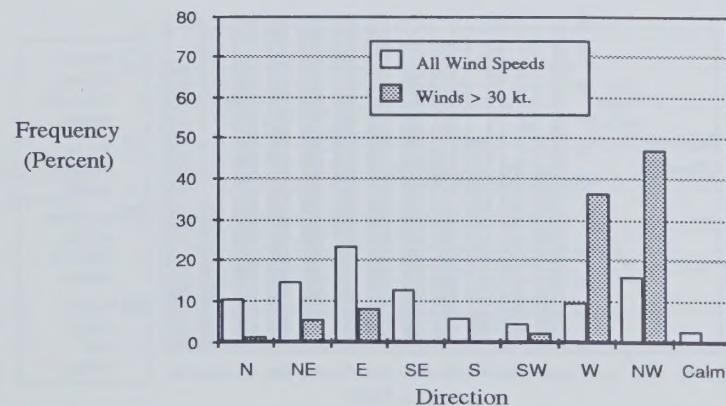


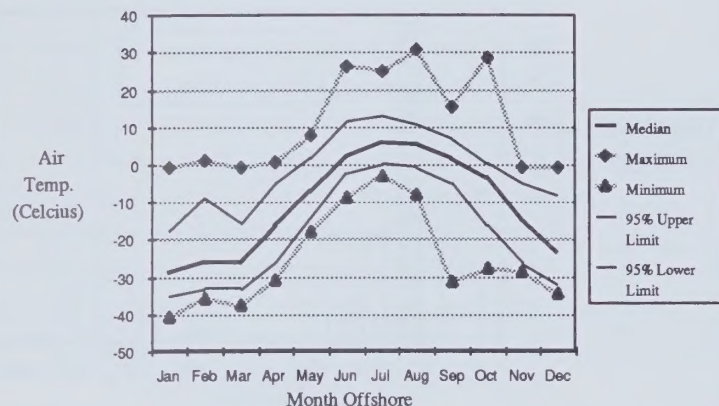
Figure 16. Wind Direction Frequencies

July to September



MARINE CLIMATIC DATA FOR LOGISTICS

Figure 17. Air Temperature



OFFSHORE

Figure 19. Frequency of Fair Weather

Visibility Greater Than 2 miles and Winds Less Than 25 knots

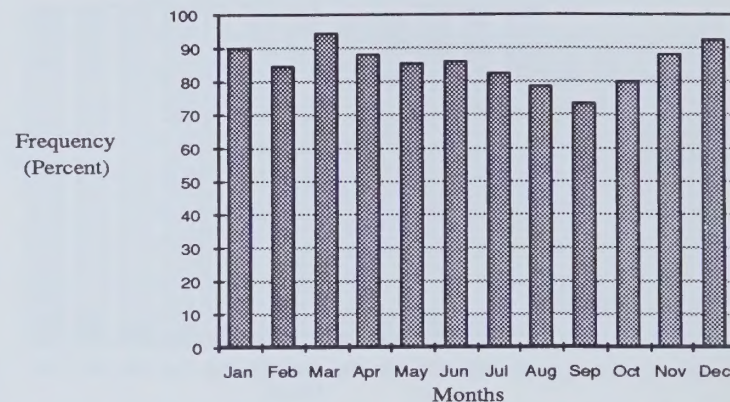


Figure 18. Frequency of Wind Chill Classes

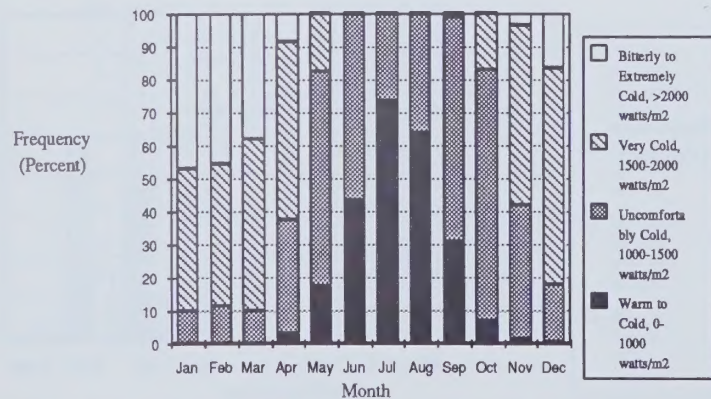
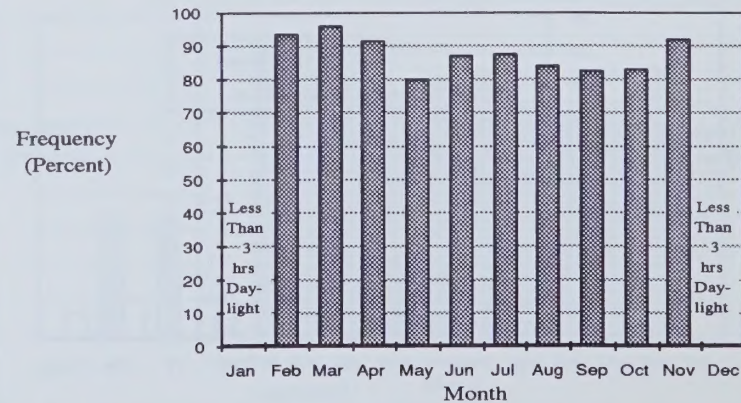


Figure 20. Frequency of Flying Weather

Visual Flight Rules, Ceiling > 1000 ft and Visibility > 2.5 miles



MARINE CLIMATIC DATA FOR LOGISTICS

OFFSHORE

Figure 21. Sea Surface Temperature

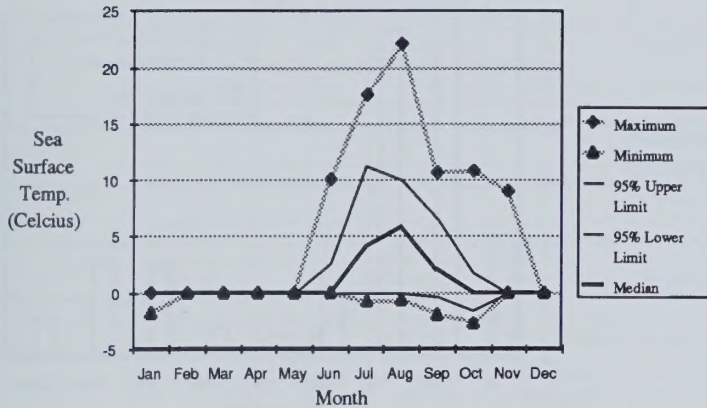


Figure 23. Wave Height Frequencies Allowing Booming Operations

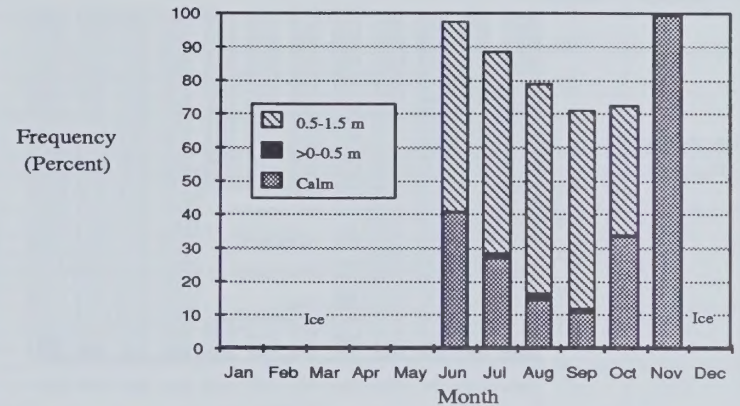


Figure 22. Potential Icing Rate Due to Freezing Spray

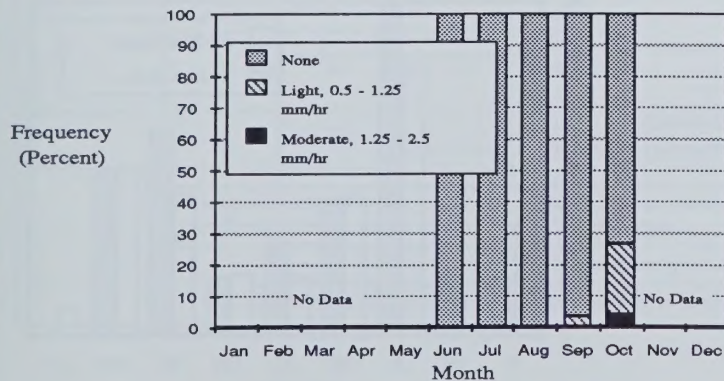
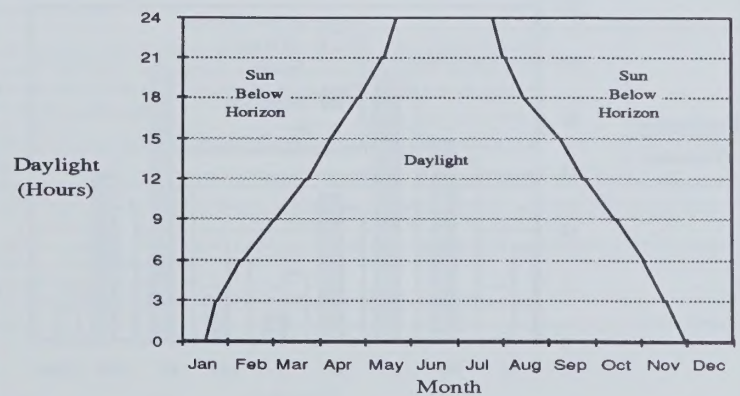


Figure 24. Duration of Daylight at 70°N



MARINE CLIMATIC DATA FOR LOGISTICS

OFFSHORE

Figure 25. Wind Speed Frequencies

All Directions

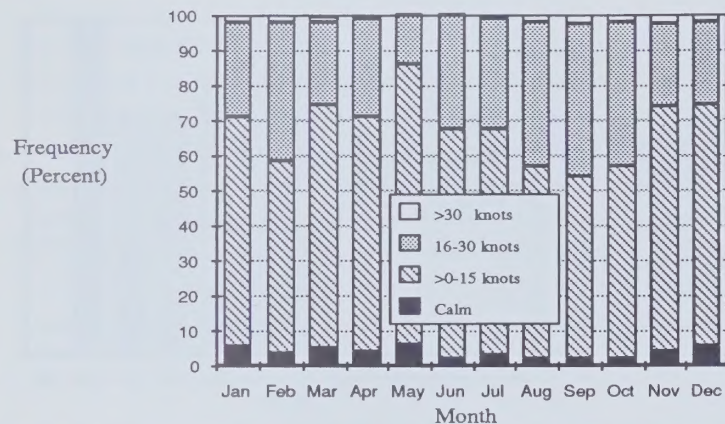


Figure 27. Wind Direction Frequencies

May to June

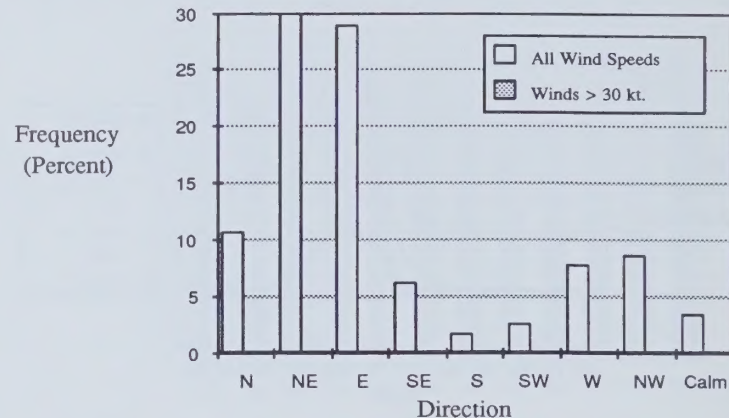


Figure 26. Wind Direction Frequencies

October to April

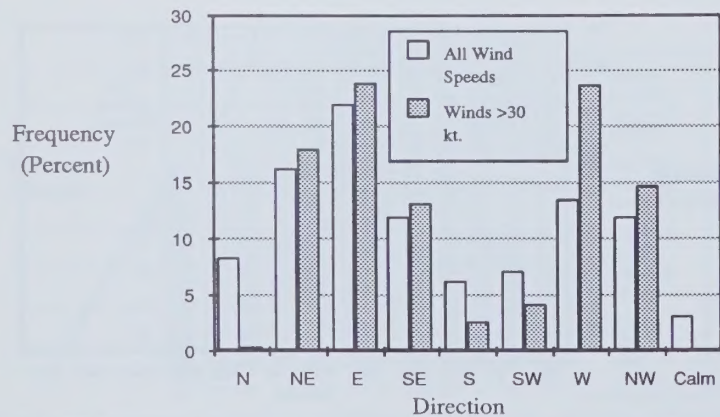
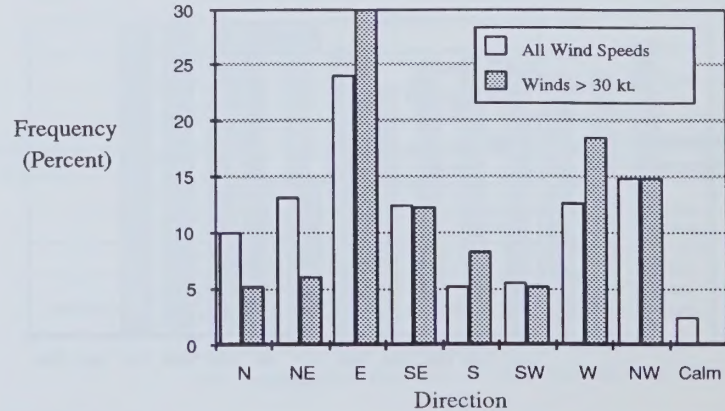


Figure 28. Wind Direction Frequencies

July to September



Description of weather and sea conditions (47)

B-11

BEAUFORT SCALE OF WIND FORCE						
Beaufort Wind Force	Mean Wind Speed in knots	Limits of Wind Speed in knots	Descriptive Term	Sea Criterion	Probable Height of Waves in metres*	Probable Maximum Height of Waves in metres*
	Measured at a height of 10 m. above sea level					
0	00	Less than 1	Calm	Sea like a mirror	—	—
1	02	1—3	Light air	Ripples with the appearance of scales are formed, but without foam crests	0.1	0.1
2	05	4—6	Light breeze	Small wavelets, still short but more pronounced, crests have a glassy appearance and do not break	0.2	0.3
3	09	7—10	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses	0.6	1.0
4	13	11—16	Moderate breeze	Small waves, becoming longer, fairly frequent white horses	1.0	1.5
5	19	17—21	Fresh breeze	Moderate waves, taking a more pronounced long form, many white horses are formed. (Chance of some spray.)	2.0	2.5
6	24	22—27	Strong breeze	Large waves begin to form, the white foam crests are more extensive everywhere. (Probably some spray.)	3.0	4.0
7	30	28—33	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind	4.0	5.5
8	37	34—40	Gale	Moderate high waves of greater length, edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind	5.5	7.5
9	44	41—47	Strong gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility	7.0	10.0
10	52	48—55	Storm	Very high waves with long overhanging crests. The resulting foam in great patches is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes a white appearance. Tumbling of the sea becomes heavy and shock-like. Visibility affected	9.0	12.5
11	60	56—63	Violent storm	Exceptionally-high waves. (Small and medium-sized ships might be for a time lost to view behind the waves.) The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the waves' crests are blown into froth. Visibility affected.		
12	—	64 and over	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.	14 or over	—

* These columns are added as a guide to show roughly what may be expected in the open sea, remote from land. In enclosed waters, or when near land with an off-shore wind, wave heights will be smaller, and the waves steeper.

Notes — (1) It must be realised that it may be difficult to estimate wind force by the sea criterion. The wind force and direction may therefore be estimated by other means, e.g. the 'feel' of the wind or the smoke, making due allowance for course and speed of ship.

(2) The lag effect between the wind getting up and the sea increasing should be borne in mind.

(3) Fetch, depth, swell, heavy rain and tide effects should be considered when estimating the wind force from the appearance of the sea.

APPENDIX C. INDEX OF PLACE NAMES

Name	Latitude Degrees Min.		Longitude Degrees Min.		Op. Map
Adgo C-15 (1975)	69	24.00	135	49.00	10
Adgo F-28 (1983)	69	27.00	135	51.00	10
Adgo G-24 (1985)	69	23.00	135	50.00	10
Adgo H-29 (1984)	69	28.00	135	50.00	10
Adgo J-27 (1976)	69	26.00	135	51.00	10
Adgo P-25 (1974)	69	25.00	135	50.00	10
Amundsen Gulf	70	30.00	123	0.00	26
Anderson River	69	41.00	128	57.00	23
Anderson River	69	42.00	129	0.00	23
Arnak K-06 (1985)	69	45.00	133	0.31	13
Arvoknar Channel	69	18.00	135	38.00	9
Atkinson Point	69	56.00	131	27.00	17
Avadlek Spit	69	34.00	139	17.00	2,3,3A
Babbage Bight	69	10.00	138	13.00	4
Babbage River	69	13.00	138	24.00	4
Backhouse River	69	37.00	140	30.00	1
Baillie Islands	70	36.00	128	13.00	26
Bare Pingo	69	29.00	132	58.00	15
Bell Bluff	69	36.80	138	55.50	3
Beluga Bay	69	33.00	134	39.00	11
Beluga Point	69	30.00	132	59.00	15
Beluga Shoals	69	48.00	132	14.00	16
Big Horn Point	69	23.50	134	50.50	12
Big Lake	69	24.50	134	56.00	12
Blow River	68	56.00	137	4.00	6
Bols Point	69	46.00	131	54.00	16
Brant Island	69	46.00	129	0.00	23
Breakers	69	59.00	131	14.00	17
Breakers	70	13.00	130	32.00	18
Burnt Creek	69	26.00	134	28.00	12
Calton Point	69	30.00	139	6.00	3,3A
Campbell Island	69	36.00	130	43.00	22
Canyanek Inlet	69	22.00	133	21.00	14
Cape Bathurst	70	35.00	128	1.00	26
Cape Dalhousie	70	15.00	129	40.00	19
Cape Sangro	69	52.00	128	36.00	23
Cape Wolki	70	6.00	128	20.00	24
Castle Bluff	69	48.00	128	46.00	23
Char Point	70	6.00	129	22.00	19

Name	Latitude Degrees Min.		Longitude Degrees Min.		Op. Map Number
Clarence Lagoon	69	37.00	140	48.00	1
Clarence River	69	37.00	140	54.00	1
Cliff Point	69	49.00	129	35.00	20,21
Cold Island	69	44.00	129	0.00	23
Collinson Head	69	34.00	138	50.00	3
Corral Bay	69	32.00	133	50.00	14
Craig Creek	69	37.00	140	54.00	1
Crescent Bank	70	11.00	130	42.00	18
Crumbling Point	69	36.00	133	54.00	13
Cy Peck Inlet	70	21.00	128	0.00	25
Denis High Hill	69	21.50	134	43.00	12
Denis Lagoon	69	22.50	134	39.00	12
Denis Lake	69	20.00	134	33.50	12
Denis Pingo	69	18.50	134	42.00	12
Difficult Creek	69	31.00	139	22.00	2
Drift Point	69	52.00	131	38.00	17
East Channel	69	50.00	79	30.00	14
Eastern Entrance	69	27.50	132	59.00	15A
Ellice Island	69	7.50	135	46.00	7,9
Ellice L-39 (1985)	69	18.50	135	50.00	9,10
Escape Reef	69	0.00	137	15.00	5
Eskimo Lakes					
(Husky Lakes)	69	27.00	131	0.00	22A
Fish Creek	69	36.00	140	7.00	1
Fish Island	69	21.00	134	53.00	12
Flagpole Point	69	27.00	133	3.00	15,15A
Flat Island	69	45.00	129	0.00	23
Fort Ross Islands	69	27.10	132	59.50	15A
Fort Hearne Island	69	27.00	132	58.25	15A
Fox Den Island	69	42.00	129	1.00	23
Garry Island	69	29.00	135	40.00	10
Grassy Point	69	45.00	128	56.00	23
Gull Island	69	30.00	133	34.00	14
Gull Islets	69	45.00	129	0.00	23
Hadwen Island	69	36.00	134	5.00	13
Hansen Harbour	69	39.00	134	11.00	13
Harrowby Bay	70	13.00	127	50.00	25
Harry Channel	69	20.00	134	57.00	12
Hendrickson Island	69	30.00	133	36.00	14
Hepburn Spit	69	56.00	128	53.00	20,20A
Herschel Basin	69	28.00	138	51.50	3

Name	Latitude Degrees Min.		Longitude Degrees Min.		Op. Map Number	Name	Latitude Degrees Min.		Longitude Degrees Min.		Op Map Number
Herschel Island	69	35.00	139	2.00	2,3,3A	Mingnuk Point	69	38.00	132	46.00	15,16
Herschel Sill	69	31.00	138	41.00	3	Ministicoog Channel	68	53.00	136	28.00	6
Hooper Island	69	41.00	134	55.00	11	Moose Channel	68	50.00	136	37.00	6
Hutchison Bay	69	43.00	132	12.00	16	Moose River	69	25.00	130	0.00	22A
Ice Lake	69	25.90	133	0.50	15A	Nadluk Camp	69	15.00	130	57.50	22A
Ikattok J-17 (1975)	69	16.00	136	18.00	9	Naparotalik Spit	69	23.00	133	22.00	14
Ikpiisugyuk Point	70	9.00	128	10.00	24	Napoiak Channel	68	40.00	135	10.00	8
Immerk B-48 (1972)	69	37.00	135	10.00	11	Neil Lake	70	22.00	128	4.00	25
Johnson Bay	70	2.00	129	30.00	20	Nesterk B-44 (1974)	69	33.00	135	56.00	10
Kay Point	69	18.00	138	22.00	4	Niarkrok Harbour	69	50.00	128	58.00	20,23
Kendall Island	69	29.00	135	16.00	10	Nicholson Island	69	55.00	128	57.00	20,20A,23
Kidluit Bay	69	30.00	133	47.00	14	Nicholson Point	69	50.00	129	2.00	20,23
Kidney Lake	70	3.50	130	46.00	18	Niglintgak Island	69	21.00	135	20.00	10
Kiktoreak Point	69	26.65	132	57.75	15A	Niutungiak Peninsula	69	40.00	132	27.00	16
Kimialik Lake	69	22.00	135	9.00	10	North Head	69	43.00	134	34.00	13
King Point	69	6.00	137	55.00	5	North Peak	69	36.00	132	56.00	15
Kittigazuit Bay	69	23.00	133	47.00	14	North Point	69	37.00	134	18.00	13
Komakuk Beach	69	35.50	140	12.00	1	North Star Harbour	70	15.00	127	38.00	25
Kriterk Point	69	25.10	132	57.75	15A	Nunaluk Spit	69	34.00	139	38.00	2
Kugaluk Camp	69	7.00	130	54.00	22A	Nuvorak Point	70	9.00	130	23.00	18
Kugaluk River	69	7.00	130	57.00	22A	Observation Point	70	39.00	128	15.00	26
Kugmallit Bay	69	33.00	133	20.00	13,14,15	Old Horton Channel	70	12.00	127	30.00	25
Kugmallit H-59 (1976)	69	38.00	133	27.00	15	Olivier Islands	69	7.00	136	9.00	9
Kukjuktuk Bay	69	39.00	132	30.00	16	Orca Cove	69	34.00	139	15.00	2,3,3A
Lake Pingo	69	36.00	132	57.00	15	Osborn Point	69	31.00	139	5.00	3,3A
Landfall Lake	69	42.00	128	47.00	23	Paaraluk Bay	69	37.00	132	42.00	15,16
Langley Island	69	1.50	135	22.00	7	Pauline Cove	69	34.00	138	55.00	3
Liverpool Bay	70	10.00	128	50.00	20,21,22, 23,25	Pelly B-35 (1974)	69	34.00	135	23.00	11
Lopez Point	69	33.00	139	12.00	2,3,3A	Pelly Island	69	36.00	135	28.00	11
Louth Bay	69	56.00	131	24.00	17	Peninsula Point	69	24.00	133	12.00	14
Mackenzie Bay	69	20.00	137	10.00	4,5,6,9,10	Phillips Island	70	6.50	130	53.00	18
Mackenzie Delta	69	7.00	135	30.00	7	Pillage Point	68	51.50	136	45.00	6
Mackenzie River	68	40.00	135	0.00	14	Pitt Island	69	11.00	136	11.00	9
Maitland Point	70	9.00	128	15.00	24	Ptarmigan Bay	69	27.00	138	58.00	3
Malcolm River	69	33.00	139	33.00	2	Pullen E-17 (1974)	69	46.00	134	19.00	13
Mason Bay	68	33.00	134	7.00	12,13	Pullen Island	69	45.00	134	23.00	13
Mason River	69	56.00	128	0.21	24	Pulsating Pingo	69	58.00	129	32.00	21
McKinley Bay	69	55.00	131	8.00	17,17A,18	Reindeer Channel	68	53.40	135	38.00	7,8
McKinley Lake	70	24.00	127	40.00	26	Reindeer Islands	69	40.00	134	14.00	13
Middle Channel	69	20.00	135	30.00	10	Relief Islet	70	9.00	130	49.00	18
Miner River	69	7.00	130	57.50	22A	Richards Island	69	20.00	134	30.00	12
						Running River`	68	55.00	137	21.00	5

Name	Latitude Degrees Min.		Longitude Degrees Min.		Op. Map Number
Russell Inlet	70	7.00	130	0.00	19
Sabine Point	69	4.00	137	44.00	5
Sakvalunat Point	69	42.50	132	14.50	16
Sanders Creek	69	34.00	130	25.00	22
Saviktok Point	69	25.80	132	58.00	15A
Scowlake Channel	68	51.00	136	49.50	6
Seal Bay	70	8.00	130	46.00	18
Seal Island	69	24.00	134	51.00	12
Shallow Bay	68	52.00	135	59.00	7,8
Shearpin Creek	69	48.00	129	2.00	23
Shingle Point	69	0.00	137	21.00	5
Shoalwater Bay	68	54.00	136	43.00	6
Shore Pingo	69	31.00	132	58.00	15
Simpson Point	69	34.00	138	55.00	3
Skiff Point	69	24.00	133	54.00	14
Smoke River	69	29.00	130	31.00	22
Snowgoose Passage	70	32.00	128	7.00	26
Stanton Channel	69	44.00	129	0.00	23
Stick Pingo	69	30.00	132	57.50	15
Summer Island	69	35.00	133	54.00	13
Swan Channel	69	26.50	134	40.00	12
Taglu Island	69	26.00	135	1.00	12
Tareoknitok Lagoon	69	26.30	133	1.5	15A
Tent Island	68	55.00	136	34.00	6
Tern Island	69	25.00	132	59.5	15A
Thetis Bay	69	34.00	138	56.00	3,3A
Thrasher Bay	69	33.00	139	11.00	2,3,3A
Thumb Island	69	28.00	130	34.50	22,22A
Tibjak Point	69	34.00	133	1.00	15
Tiktalik Channel	68	50.00	135	57.00	8
Tininerk Bay	69	37.00	132	57.00	15
Toker Pingo	69	37.80	132	54.00	15
Toker Point	69	39.00	132	50.00	15
Topkak Point	69	30.00	133	1.00	15
Trent Bay	68	58.00	137	12.00	5,6
Triangle Island	69	43.00	129	4.00	23
Tuft Point	69	43.00	132	34.00	16
Tuktoyaktuk	69	26.00	133	2.00	15,15A
Tuktoyaktuk Harbour	69	26.00	133	0.00	15,15A
Tuktoyaktuk Island	69	27.00	133	1.00	15,15A
Tuktoyaktuk Peninsula	69	55.50	130	27.00	16-19,21,22

Name	Latitude Degrees Min.		Longitude Degrees Min.		Op. Map Number
Umiak Lake	69	23.50	134	23.00	12
Unark L-24 (1974)	69	33.00	134	37.00	12,13
Wallace Bay	69	34.00	134	14.00	13
Warren Point	69	45.00	132	19.00	16
Welles Point	69	33.00	139	18.00	2,3A
West Atkinson L-17 (1981)	69	45.00	132	0.00	16
West Channel	68	50.00	136	9.00	7,8
West Point	69	30.00	134	34.50	12
Western Entrance	69	27.40	133	1.50	15A
Whale Bay	69	26.00	139	2.00	3
Whale Bluff	70	22.00	127	32.00	25
Whitefish Pingo	69	23.00	133	30.00	14
Whitefish Station	68	54.00	136	54.00	6
Wood Bay	69	46.00	129	0.00	20,20A 23,24
Workboat Passage	69	31.50	139	13.00	2,3,3A
Yukon/NWT Border	68	52.00	136	27.50	6

APPENDIX D. WMO SEA ICE NOMENCLATURE (48)

Brash ice: Accumulations of floating ice made up of fragments not more than 2 m across, the wreckage of other forms of ice.

Close pack ice: Pack ice in which the concentration is 7/10 to 8/10 (6/8 to less than 7/8), composed of floes mostly in contact.

Compact pack ice: Pack ice in which the concentration is 10/10 (8/8) and no water is visible.

Concentration: The ratio in tenths of the sea surface actually covered by ice to the total area of sea surface, both ice-covered and ice-free, at a specific location or over a defined area.

Consolidated pack ice: Pack ice in which the concentration is 10/10 (8/8) and the floes are frozen together.

Deformed ice: A general term for ice which has been squeezed together and in places forced upwards (and downwards). Subdivisions are rafted ice, ridged ice and hummocked ice.

Fast ice (also called Landfast Ice): Sea ice which forms and remains fast along the coast, where it is attached to the shore, to an ice wall, to an ice front or between shoals. Vertical fluctuations may be observed during changes of sea-level. Fast ice may be formed in situ from sea water or by freezing of pack ice of any age to the shore, and it may extend a few metres or several hundred kilometres from the coast. Fast ice may be more than one year old and may then be prefixed with the appropriate age category (old, second-year, or multi-year). If it is thicker than about 2 m above sea-level it is called an ice shelf.

Fast-ice boundary: The ice boundary at any given time between fast ice and pack ice.

Fast-ice edge: The demarcation at any given time between fast ice and open water.

Finger rafting: Type of rafting whereby interlocking thrusts are formed, each floe thrusting "fingers" alternately over and under the other. Common in nilas and grey ice.

First-year ice: Sea ice of not more than one winter's growth, developing from young ice; thickness 30 cm - 2 m. May be subdivided into thin first-year ice/white ice, medium first-year ice and thick first-year ice.

Flaw lead: A passage-way between pack ice and fast ice which is navigable by surface vessels.

Flaw polynya: A polynya between pack ice and fast ice.

Floe: Any relatively flat piece of sea ice 20 m or more across. Floes are subdivided according to horizontal extent as follows:

Giant: Over 10 km across.

Vast: 2-10 km across.

Big: 500-2,000 m across.

Medium: 100-500 m across.

Small: 20-100 m across.

Flooded ice: Sea ice which has been flooded by melt-water or river water and is heavily loaded by water and wet snow.

Frazil ice: Fine spicules or plates of ice, suspended in water.

Grease ice: A later stage of freezing than frazil ice when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matt appearance.

Grey ice: Young ice 10-15 cm thick. Less elastic than nilas and breaks on swell. Usually rafts under pressure.

Grey-white ice: Young ice 15-30 cm thick. Under pressure more likely to ridge than to raft.

Hummocked ice: Sea ice piled haphazardly one piece over another to form an uneven surface. When weathered, has the appearance of smooth hillocks.

Ice boundary: The demarcation at any given time between fast ice and pack ice or between areas of pack ice of different concentrations.

Ice cake: Any relatively flat piece of sea ice less than 20 m across.

Ice cover: The ratio of an area of ice of any concentration to the total area of sea surface within some large geographic local; this local may be global, hemispheric, or prescribed by a specific oceanographic entity such as Baffin Bay or the Barents Sea.

Ice edge: The demarcation at any given time between the open sea and sea ice of any kind, whether fast or drifting. It may be termed compacted or diffuse.

Ice-free: No sea ice present. There may be some ice of land origin.

Ice limit: Climatological term referring to the extreme minimum or extreme maximum extent of the ice edge in any given month or period based on observations over a number of years. Term should be preceded by minimum or maximum.

Landfast ice: see Fast ice.

Lead: Any fracture or passage-way through sea ice which is navigable by surface vessels.

Level ice: Sea ice which is unaffected by deformation.

Medium first-year ice: First-year ice 70-120 cm thick.

Multi-year ice: Old ice up to 3 m or more thick which has survived at least two summers' melt. Hummocks even smoother than in second-year ice, and the ice is almost salt-free. Colour, where bare, is usually blue. Melt pattern consists of large interconnecting irregular puddles and a well-developed drainage system.

New ice: A general term for recently formed ice which includes frazil ice, grease ice, slush and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat.

Nilas: A thin elastic crust of ice, easily bending on waves and swell and under pressure, thrusting in a pattern of interlocking "fingers" (finger rafting). Has a matt surface and is up to 10 cm in thickness. May be subdivided into dark nilas and light nilas.

Old ice: Sea ice which has survived at least one summer's melt. Most topographic features are smoother than on first-year ice. May be subdivided into second-year ice and multi-year ice.

Open pack ice: Pack ice in which the ice concentration is $\frac{4}{10}$ to $\frac{6}{10}$ ($\frac{3}{8}$ to less than $\frac{6}{8}$), with many leads and polynyas, and the floes are generally not in contact with one another.

Open water: A large area of freely navigable water in which sea ice is present in concentrations less than $\frac{1}{10}$ ($\frac{1}{8}$). When there is no sea ice present, the area should be termed ice-free.

Pack ice: Term used in a wide sense to include any area of sea ice, other than fast ice, no matter what form it takes or how it is disposed.

Polar pack: Pack ice in which old ice is present in concentrations greater than or equal to $\frac{5}{10}$.

Pancake ice: Predominantly circular pieces of ice from 30 cm - 3 m in diameter, and up to about 10 cm in thickness, with raised rims due to the pieces striking against one another. It may be formed on a slight swell from grease ice, shuga or slush or as a result of the breaking of ice rind, nilas or, under severe conditions of swell or waves, of grey ice. It also sometimes forms at some depth, at an interface between water bodies of different physical characteristics, from where it floats to the surface; its appearance may rapidly cover wide areas of water.

Polynya: Any non-linear shaped opening enclosed in ice. Polynyas may contain brash ice and/or be covered with new ice, nilas or young ice; submariners refer to these as skylights. Sometimes the polynya is limited on one side by the coast and is called a shore polynya or by fast ice and is called a flaw polynya. If it recurs in the same position every year, it is called a recurring polynya.

Puddle: An accumulation on ice of melt-water, mainly due to melting snow, but in the more advanced stages also to the melting of ice. Initial stage consists of patches of melted snow.

Rafted ice: Type of deformed ice formed by one piece of ice overriding another.

Recurring polynya: A polynya which recurs in the same position every year.

Ridge: A line or wall of broken ice forced up by pressure. May be fresh or weathered. The submerged volume of broken ice under a ridge, forced downwards by pressure, is termed an ice keel.

Ridged ice: Ice piled haphazardly one piece over another in the form of ridges or walls. Usually found in first-year ice.

Ridging: The pressure process by which sea ice is forced into ridges.

Rotten ice: Sea ice which has become honeycombed and which is in an advanced state of disintegration.

Sea ice: Any form of ice found at sea which has originated from the freezing of sea water.

Second-year ice: Old ice which has survived only one summer's melt. Because it is thicker and less dense than first-year ice, it stands higher out of the water. In contrast to multi-year ice, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.

Shearing: An area of pack ice is subject to shear when the ice motion varies significantly in the direction normal to the motion, subjecting the ice to rotational forces. These forces may result in phenomena similar to a flaw.

Shore lead: A lead between pack ice and the shore or between pack ice and an ice front.

Shore polynya: A polynya between pack ice and the coast or between pack ice and an ice front.

Shuga: An accumulation of spongy white ice lumps, a few centimetres across; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface.

Slush: Snow which is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snow-fall.

Thaw holes: Vertical holes in sea ice formed when surface puddles melt through to the underlying water.

Thick first-year ice: First-year ice over 120 cm thick.

Thin first-year ice/white ice: First-year ice 30-70 cm thick.

Transition zone: An area of pack ice between fast ice and the polar pack that is subject to shearing.

Very close pack ice: Pack ice in which the concentration is 9/10 to less than 10/10 (7/8 to less than 8/8).

Very open pack ice: Pack ice in which the concentration is 1/10 to 3/10 (1/8 to less than 3/8) and water preponderates over ice.

Weathering: Processes of ablation and accumulation which gradually eliminate irregularities in an ice surface.

Young coastal ice: The initial stage of fast ice formation consisting of nilas or young ice, its width varying from a few metres up to 100-200 m from the shore.

Young ice: Ice in the transition stage between nilas and first-year ice, 10-30 cm in thickness. May be subdivided into grey ice and grey-white ice.

APPENDIX E. ATLAS PRODUCTION

1.0 COMPUTERIZED MAPS

ESL Environmental Sciences Limited produced digitized microcomputer files and plotted all hard copy products of all map bases and overlay information produced for the atlas. Approximately 22 of the scale 1:150,000 map bases were translated from digitized files kindly provided by the Canadian Hydrographic Service (CHS), Patricia Bay, B.C. with the understanding that none of the digitized information would be used for navigational purposes. To aid in this request, all major navigation information was removed from the files by ESL and a notice has been printed in the introduction to this atlas indicating they should not be used for navigational purposes.

All of the final maps were produced using the AUTOCAD Version 2.18 Computer Aided Drafting (CAD) package produced by Autodesk Inc. and purchased by EPS Yellowknife. ESL also wrote special software routines and used a PDP-11 minicomputer to translate NTX formatted files (i.e. the operational maps provided by CHS) into files that could be used by AUTOCAD on a microcomputer.

A total of 25 different map bases were required for the atlas. The following table provides information on the numbers of maps at each scale, the map base name and the digitizing source.

Table E1
Map Base Details

Number	Scale	Map Base Name	Digitizing Source
1	1:2,500,000	Summary	ESL
2	1:1,000,000	Regional	ESL
27	1:150,000	Operational	CHS/ESL
5	1:50,000	Tactical	CHS/ESL

2.0 COMPUTERIZED TEXT

All the original text files were produced using MacWrite (version 4.5) on an Apple Macintosh. Text files were transferred to Pagemaker (version 1.2 by Aldus Corporation) for page layout. All final text pages are stored on double sided 800 k floppydisks.

3.0 ARCHIVING AND UPDATING

All final computer map and text files reside at the offices of:

Environment Canada
Environmental Protection Service
Conservation and Protection
N.W.T. District Office
P.O. Box 370
Yellowknife, N.W.T. X1A 2N3
(403) 873-3456

Any revisions, amendments, and comments regarding this atlas should be forwarded to the above address.

Corporate Author:

Environmental

Atlas for Beaufort

Series:

Sea Oil

Title:

Spill Response

RESOURCE CENTRE
INST. FOR ENVIRON'L. STUDIES
UNIVERSITY OF TORONTO



PRINTED IN CANADA

ISBN 0-921623-03-8

ISBN 0-921623-03-8